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Gambiance: Exploring New Roles of Light in Board Games Beyond Illumination

Master's Thesis

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Aalto University School of Science Master's Programme in ICT Innovation	ABSTRACT OF THE MASTER'S THESIS

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Abstract:

In this thesis we will present a study on using lighting to enhance the gameplay of modern board games. Informed by observing board gaming events and getting engaged on forums we learned that besides debating strategies and the game mechanics, another regular discussion is on how to create good environments for games and playing. Based on our findings we frame the design space of light extended board games and propose three types of roles that lighting could play in board games to enhance the gameplay experience: (1) ambiance support for decorative purposes, eg. creating thematic atmosphere, (2) gameplay elements like thematic timers, and (3) game tools such as lighting objects that players can interact with. We designed a light extended board game prototype in order to evaluate several ambiance support and gameplay element role concepts. A Wizard-of-Oz test verified that players experience an enhanced focus using the light extended game. On the other hand, some ambiance support also distracted players. Thematic indications enhance sensory immersion, and randomly triggered elements can make the game more exciting by causing surprise and uncertainty, while reducing player effort. Finally, we conclude this thesis by discussing results and outlining future work.

Keywords: **design, ambient light, board game, blended board game, user testing, HCI, hybrid game, user experience.**

Abstract

In this thesis we will present a study on using lighting to enhance the gameplay of modern board games. Informed by observing board gaming events and getting engaged on forums we learned that besides debating strategies and the game mechanics, another regular discussion is on how to create good environments for games and playing. Based on our findings we frame the design space of light extended board games and propose three types of roles that lighting could play in board games to enhance the gameplay experience: (1) ambiance support for decorative purposes, eg. creating thematic atmosphere, (2) gameplay elements like thematic timers, and (3) game tools such as lighting objects that players can interact with. We designed a light extended board game prototype in order to evaluate several ambiance support and gameplay element role concepts. A Wizard-of-Oz test verified that players experience an enhanced focus using the light extended game. On the other hand, some ambiance support also distracted players. Thematic indications enhance sensory immersion, and randomly triggered elements can make the game more exciting by causing surprise and uncertainty, while reducing player effort. Finally, we conclude this thesis by discussing results and outlining future work.

Contents

List of Figures

List of Tables

1

Introduction

The first chapter introduces the topic of light extended board games. We start by outlining the domain of social games and smart computing environments, in which our topic takes place. Then we explain why we think the combination of board games and lighting could be beneficial. Finally we set out our research questions and introduce the methodology we aim to use to tackle these questions.

1.1 Towards social digital games

Games have a long and continuing history in the development of almost every culture and society. While non-electronic games are almost all collective in nature, by 2000 the vast majority of electronic games were individual [57]. Despite the fact, that numerous researches showed, that physical body movements and social interactions are not just essential for the enjoyment of life [14], but can also create games additionally interesting and rewarding to participants [17, 20].

Since then, new technologies were introduced that in some way tried to expand the social and physical aspects of computer games, such as online multiplayer games [57], physical games [47] (Nintendo Wii , Microsoft Kinect). Nevertheless, the social richness of these games, even the ones that were co-located, were far from being near the richness of other popular game types such as board games [38].

While the general approach in developing these innovations has been to turn something digital into more social and physical, in this thesis we propose an alternative approach. That is to start from something already social and physical, and discover how its gameplay experience can be enhanced by digital solutions.

This thesis work has been carried out at the Experience Research department at Philips Research in Eindhoven. The task was to find a relevant area of research in home entertainment where there is opportunity for innovation by combining products with Philips Hue lights. Our choice was social gaming, with a focus on board games.

1.2 Backround

A myriad of research projects are currently exploring the challenges of providing ubiquitous computing functionality invisibly embedded in homes and offices [50, 37]. This area has benefited vastly from the spread of Internet of Things. New connected devices allow seamless integration of physical and virtual worlds [1], which opens new dimensions for more natural interactions between users and technology.

As a complementary trend to the integration of pervasive computing technologies to other home and office applications, computer games have also recently begun to leave the traditional screen-oriented interaction paradigms. So-called hybrid and

pervasive games [37, 10] bridge the gap between virtual and physical worlds by making the physical context of the players, their locations, and real-world parameters, an integral part of the gaming experience. The main goal of these kinds of games is to combine the benefits of both traditional games and computer games. That is the rich social situation and real world parameter on the traditional games' side, and complex game rules, smart and proactive behaviour and multi sensual stimulation on the computer games' side [37].

1.3 Problem

According to global business intelligence company, ON World's research, smart lighting is one of the most active segment of the Internet of Things. Philips released its Hue light product line in 2012. This product is connected to the home network and provides dynamic control over the full spectrum of colour. As a result of its open API, it provides a new interface for numerous new innovations. One example is Disney's Storytime app [36], that allows children and parents to interactively create a lighting experience that helps families become more fully immersed in the story.

According to several sources [25, 44], there is a secular trend in gaming away from games played on a screen, toward tabletop games played in person with other players, which has been going on for a several years. Sales of family board and action games are booming [44], they grew 5% in 2012, 14% in 2013 and 20% in 2014 [8].

While there has been some researches investigating the effect of projecting visuals on the board of the games, other ways of using light to enhance the gameplay experience of board games are rather unexplored. However, the recent popularity of room escape games [42] that are sometimes also referred to as real life board games, show an inclination for more immersive social games. We speculate that with the help of light we can expand traditional board games by increasing players' immersion and flow. Thus, in our research we wish to challenge the previously mentioned trends and investigate how the emerging LED technology can be used to enhance the gameplay of board games. As a result, this thesis addresses the following research question:

How can light enhance the gameplay of modern board games?

To address this question, first it is essential to understand the different elements that a game consists of, and how player play them. These elements can be then mapped into categories of possible roles that light could play in board games. The categories recognised during the project (Section 4.4) are briefly explained below.

Ambience support. The first category is the ambience support that is mainly used for decorative purposes to create theme dependent atmosphere and in this way support immersion. As an example, in football, ambience is the sound of the audience and the weather conditions.

Gameplay elements. The second type of roles are gameplay elements that host game state information and support rules. In football the score table and the judges are gameplay elements.

Game tools. The third type of roles are game tools, that users can directly interact with and change their state. Their usage is necessary to achieve the goals of the game. In football an important game tool is the ball.

These 3 types of roles will serve to form sub-questions that need to be explored in order to answer the main research question. The sub-questions are the followings:

1. **What roles can light play in social games as ambience support?**
2. **What roles can light play in social games as gameplay elements?**
3. **What roles can light play in social games as game tools?**

1.4 Purpose

In this thesis we explore possible roles that light can play in modern board games beyond illumination. These roles can be extensions of existing games or main components of totally new games that are based on interactive lighting.

1.5 Goal

The design space of light extended board games is going to be framed and discussed that can inform and inspire Philips Research and other designers of future light extended board games. Furthermore, several light role concepts are going to be selected, prototyped and tested to reveal their effect on the gameplay experience of board games.

1.6 Methodology

To fulfill these goals, a background research was conducted in order to frame the domain for light extended board games. This exploration included information both about the commercial board game market and state of the art research in the area, which provides answers for the following questions:

1. What are the popular board games currently and why those?
2. What experience do they provide to players?
3. Who are the players and what are their characteristics?
4. How is light currently used in these games?
5. Are there any examples of digitally extended board games out on the market?
6. What is the current state of researches in the area of digitally extended board games?

Besides our table research, in order to familiarize with different types of board games, their mechanics and dynamics and to meet the players, we also visited several board gaming nights. As it is stated by Stenros [49]: "In order to understand how a game functions and what it is like to play a game, it is imperative to play the game.".

Based on the gathered information, the design space for light extended games has been formulated. After focusing this design space, several ambience support and gameplay element role concepts have been selected for further exploration. As games are bundles of rules and mechanics that work together to provide a

pleasurable gameplay experience, in order to evaluate the different light role concepts, each of them were designed into the context of a game. This game was then used for a user study to assess the effect of each light role concept on the gameplay experience.

2

Related work

In this chapter we introduce the state of the art research that informs our project. Firstly, we introduce the area of smart computing environments that enables such innovations. Secondly, we outline the fields of pervasive games, blended board games and ambient lighting, as these fall the closest to our research topic. Finally, we discuss the most often used measures of gameplay experience and methods for its evaluation.

2.1 Technological enablers

A myriad of research projects is currently exploring the challenges of providing ubiquitous computing functionality invisibly embedded in homes and offices [50, 37]. These researches have two main drivers. One of them is the progression of Internet of Things devices and the other is the profound changes [1] in HCI that define the human experience with smart computing environments [37].

These changes include firstly new natural interactions with the physical world that provide sufficient input without any additional actions being necessary to inform the virtual domain. Secondly, there are more natural ways of communicating information back to the users, so that they do not become distracted from their actual tasks. Thirdly, the seamless integration of physical and virtual worlds, that results in hybrid information spaces in which physical and computational artifacts are merged into hybrid objects.

According to global business intelligence company, ON World's research, by 2020, there will be over 100 million Internet connected wireless light bulbs and lamps worldwide up from 2.4 million in 2013 [46]. With this result smart lighting is one of the most active segment of the Internet of Things. The market leader Philips released its Hue lights in 2012. This product is connected to the home network and provides dynamic control over the full spectrum of color. It provides an interface for numerous new innovations.

2.2 Pervasive games

As a complementary trend to the integration of pervasive computing technologies to other home and office applications, computer games have also recently begun to leave the traditional screen-oriented interaction paradigms. So-called hybrid or pervasive games [37, 10] bridge the gap between virtual and physical worlds by making the physical context of the players, their locations, and real-world parameters, an integral part of the gaming experience. The main goal of these kinds of games is to combine the benefits of both traditional games and computer games. That is the rich social situation and real world parameter on the traditional games' side, and complex game rules, smart and proactive behaviour and multi sensual stimulation on the computer games' side [37].

Most of the research on pervasive games includes games that are spatially and socially expanded, meaning that most of them happen in public environments. As a result they fall quite far from the current project. Despite of this, the area still provides useful hints for evaluating social games. These are going to be explained shortly in the "Evaluating game experience" section (Section 2.6).

2.3 Blended board games

While the area of light extended board games is rather unexplored, there has been some interesting research conducted about board games blended by digital technology. In the work of Wallace et al. [53] the gameplay of the cooperative board game Pandemic was compared across interfaces that incorporated varying levels of automation. The automation handled game events and progression, communicated the results through animation, and enforced rules. The preliminary results of the study revealed that automating routine activities, such as shuffling cards and moving pawns reduced the level of player effort significantly, but this happened on the expense of player enjoyment. The authors interpret this result as the design considerations in adapting board games to the digital platform.

In their work, Al Mahmud et al. [2] developed a digital table top game with the help of projecting visuals on a table, which was used as the board of the game. Unlike in the previous project, their game was controlled by tangible pawns, similarly to ordinary board games. Their evaluation showed that the player enjoyment was not just maintained when playing the digital game compared to the analogue version, but participants reported enhanced immersion as a result of the interactive visual effects, provided by the projection.

Another interesting insight is provided by the experiences of Narahara [41] who organized a course at New Jersey Institute of Technology, where students explored the possibilities of producing their own original board games by altering various existing game structures through application of new technologies such as digital prototyping, including laser cutting and 3-D printing, and microcontroller technologies. The course was motivated by the fact, that existence of tangible game pieces, boards, and real human players can produce cooperation, engagement, and tensions unlike those in video games and AR-based applications. One of their findings that can somewhat inform this project is hybridization. According to the concept by maintaining intellectual tensions, that exist in classic

abstract strategy games, while adding features from games that require physical skills to play, can create a completely new hybrid game.

2.4 Lighting

Unlike in the previously introduced projects, we are aiming to provide visuals around the people in the room as well as on the board. Our goal is to create an immersive, interactive environment that is tightly connected to the game by ambient light. Several researches have showed that ambient light can be used to create such phenomena. Waltl et al. [54] explored the impact of adding lighting and other sensory inputs to the multimedia presentations (e.g. movies), the results of the study showed an improved user experience and sense of immersion. Vogels [52] has identified light parameters that can affect the perception of the atmosphere in the room (e.g. cosiness vs. liveliness). Furthermore, the potential of the imerging LED technology has been recognised by Aliakseyeu and colleagues who set up lighting workshops on the international conferences INTERACT 2011 [7], AmI 2011 [6], DIS 2012 [4], CHI 2013 [5], and NordiCHI 2014 [3]. Here topics included ambient intelligence, interaction design, user interfaces, user studies, evaluation methodologies, connectivity with other systems, degree of autonomous behaviour, and embedded lights in daily objects.

2.5 Game experience

One of the most influential theories of fun and creative action, the flow theory by Mihaly Csikszentmihalyi [21], identifies the flow state as a particular successful balance of the perceived level of challenge and the skills of the person. In this highly intensive state, one is fully absorbed within the activity, and one often loses one's sense of time and gains powerful gratification. [24] Digital games are generally excellent in providing opportunities for flow-like experiences since the challenges they present are often gradually becoming more demanding and thus players end up acting at the limits of their skills. [24]

A similar term is immersion, it is widely used in discussing digital games and gameplay experiences [24]. Players, designers and researchers use it as well, but often in an unspecified and vague way without clearly stating to what kind of

experiences or phenomena it actually refers to. Immersion is typically used to describe the experience of becoming engaged in the game-playing experience while retaining some awareness of one's surroundings [16]. The gamplay experience model proposed by Ermi and Mayra [24] distinguishes between three categories of immersion: sensory, challenge-based and imaginative.

While certain games can offer strong moments of flow and immersion, yet neither model can capture the full gameplay experience [49]. In addition, different people can experience different types of fun when playing the same game. This applies to board games even more, as a result of their multiplayer aspect. While one can be in leading position, others can be beginners and confused. Thus, Ijsselsteijn [31] proposes the combination of multiple measurement modalities (Sensory and Imaginative Immersion, Tension, Competence, Flow, Negative Affect, Positive Affect, and Challenge) when assessing gameplay experience, resulting in increased robustness and wider applicability of the total set of measures.

2.6 Evaluating game experience

Measuring user experience in board games is broadly unexplored with research mainly focused on digital games. The closest fields which may serve with adequate evaluation methodology are the fields of pervasive games because of their social aspect and digital games because of their digital, co-located aspect. According to Stenros [49], participatory play and observation are particularly valuable methods when used in concert with post game interviews for evaluating pervasive games. Tapping into player communication is the most reliable means of capturing player confusion and frustration, and it is also a great source for understanding the gameplay activity. It also allows the researcher to later ask the right questions and contextualize the answers, although interviews allow a more general view on experiences on the game.

While the suggested methods for pervasive games are more or less qualitative, in the field of digital games, questionnaires [34, 30, 16] are also used to assess the gameplay experience. As it was mentioned in the previous section, the Game Experience Questionnaire (GEQ) presented in [30], distinguishes between seven different measures of player experience. According to Ijsselsteijn [32], this large range of measures, from reflective (subjectively controllable) to fully reflexive (uncontrollable) responses, enables a fuller characterization of the game experience

than any single isolated measure, thus sensitizing us to the rich gamut of experiences associated with digital games. In addition, this questionnaire is also validated for board games by Barbara [9].

3

Framing the domain of light extended board games

In this chapter we outline the domain of board games. We start by explaining the methodology of acquiring our information, then briefly discussing the past and present of board games. After this we introduce currently popular board games and their characteristics, then two main player types. We close the chapter by introducing examples of extended board games or other related games along with the current usage of light in board games.

3.1 Methodology

Board game enthusiastics are very active online, in forums and social media. Thus, tapping into this material becomes naturally a key source for desk research, besides other academic sources. One example is the site BoardGameGeek[1], which is a large international community with over 1,000,000 users, as of February 18, 2015. It provides resource for the board gaming hobby. Its database holds reviews, articles, session reports, images, videos, and files for over 77,000 different games and expansions, and over 21,000 game designers [13]. Discussions on these forums were a great source of information concerning, opinions about different type of games and to discover current usage of light in games.

To complement this research with empirical experience, we also conducted an ethnographic study. As Stenros [49] says, in order to understand how a game functions and what it is like to play a game, it is imperative to play the game. Studying participatory culture requires participatory methodology. Therefore we visited 6 different board gaming events both in Eindhoven and Budapest. On these events we met and played together with numerous different players and got to know 35 board games. Firstly it was important in order to put all the secondary information we learned into context and in this way gain deeper understanding of the area. Secondly it provided us with a tool case for grounding our future concepts in our design process.

3.2 Board games

A board game is a game that involves counters or pieces moved or placed on a pre-marked surface or board, according to a set of rules. Games can be based on pure strategy, chance (e.g. rolling dice), or a mixture of the two, and usually have a goal that a player aims to achieve. [12] The concept of board games goes back to as far as 3500 BC to the Predynastic Egypt where Senet [45], the oldest known board game was played. One of the reasons why we think the area of board games is an interesting field is the current popularity they have grown recently. According to ICv2 [8] board game purchases rose by between 25% and 40% in the past four years annually. Articles attribute several reasons behind this growth.

[1]BoardGameGeek - `http://www.boardgamegeek.com`

One of them is the easily accessible, rising online content about them [40]. Board games enthusiasts discuss, review and rate games online that creates an online word of mouth. Companies like Days of Wonder publishes easily accessible tablet versions of their games that drive the purchases of the analogue games. Game cafes are opening world wide [48], where players can play the games for free and also learn the rules with the help of the employees. According to some sources [40, 48] another reason is the high level of online connectedness. Socialization is limited to social media nowadays. People start to recognize the need for real social interaction. Board games may help ease the way back into face to face conversations.

3.2.1 Modern board games

While games have been getting more and more accessible in the last few years, according to players and designers they have been also getting better [23]. According to Woods [55], classic board games, such as Ludo and Monopoly are recognized to have bad design decisions and as a result, up-to-date players refuse to play them. This phenomena can also be confirmed by our observations on the board game nights, where these games were not played by anyone, and one could not find them on the shelves either. Just to mention a few of their flaws that were recognised by players on Boardgamegeek forums according to Woods [55]:

- Long player turns that make the game boring.
- Player turns are often not important to pay attention to for others players, which causes the lack of continuous engagement.
- The mechanic of player elimination causes long boring minutes for players.
- There is often no chance of getting back if a player makes mistakes in the beginning of the game. Which then results in disappointment and lack of engagement.
- Games are often based on randomization over strategy, so in the end it is not the player who is in control of the outcome of the game.

(a) Monopoly.

(b) Ludo.

While games with the previously mentioned bad design decisions can be boring or even disappointing for very competitive players, new type of games are popping up on the market that offer enhanced game play experience. Most of these games, that we will just call modern board games in this thesis, fall into to group of Eurogames. Rules are usually basic, so easy to understand, but at the same time include inventive game mechanics, that offer adequate strategic depth to be able to engage in a pleasurable intellectual activity. In addition, this activity is also enhanced by nice components and wonderful themes. These games are not just more enjoyable, but also require comparatively small time investment compared to older designs [55]. These games are far easier to fit into a player's life. Great examples for these games are Ticket to Ride or Settlers of Catan, that can also be found amongst the 10 top selling board games on Amazon. These new wave games are gaining visibility outside board game enthusiast (hobbyist) circles, families start to play more new wave games [18].

3.2.2 Elements of board games

While the previous section gave an overview of board games, this section goes more in depth and introduces their main characteristics with a focus on modern board games. According to Aki Jarvinen's framework [33], games consists of three types of elements. These are systematic, compound and the behavioural elements.

Systemic elements

Systemic elements constitute the game world in terms of spatial characteristics and elements to be utilized and configured. In terms of board games, firstly these are the components that constitute the objects the player can manipulate through the course of play. These can be objects such as dices, cards, pawns, tiles and coins. Secondly, the environment that defines the spatial arrangement of the game. Which is usually a table based environment where boards or ties are used, but there are also typically card and dice games that do not require a table based environment.

Compound elements

Compound elements include the ruleset, mechanics, information and theme. These link the systemic elements with the behavioural ones, and determine the games' dynamic.

Ruleset. The game's rule system provides the platform for a meaningful activity [49]. The rules describe and constrain the behaviours of other elements within the game system.

Mechanics. Game mechanics is a functional game feature that describes the possible means with which the player can interact with the game elements as she is trying to influence the game state in order to achieve the goal of the game. These mechanics can be varying such as dice rolling, card drafting, co-operative play, area control, acting and pattern recognition. However, according to Wood's findings, players do not generally favour a particular mechanic, but rather the gestalt experience provided by their implementation.

Information. The nature of board games is sequential, meaning that players make decisions in turns, based on the information provided by actions of other players and current game state represented by systematic elements (environment and components). As a result, information can be firstly, hidden by the game system by introducing random elements such as hidden cards or tiles, or elements triggered by dice. Although the nature of these actions is known, the exact order in which they will be made available is not, thus adding unpredictability to an otherwise relatively procedural game.

Secondly, the information can be hidden by individual players. In this way, the

game is far less susceptible to logical analysis, since a player is not aware of every possibility and consequence of other players' actions. While the first type of information provides more luck, this offers more strategy.

Theme. Most of the modern board games' ruleset currently out on the market is themed. The application of these themes to the mechanics and goals, while not strictly necessary, serves to make the games more readily understandable, and also provides the players with a role around which their actions within the game can be contextualized. As a result, themes can function to draw players into the fictional world of the game and thus enhance the players' experience.

While the level of connectedness of the themes with the mechanics and goals varies, in most modern board games it is high. However, there are also examples where the purpose of themes are pure decoration and could be changed to other themes without the need of changing anything in the rules.

While the goal of classical unthemed games such as Chess and Go is to be mastered and be better in it from day to day, modern themed games are not games to master. These games does not offer that high level of strategic depth. But on the other hand, each of them provides a different story with a different experience that is nice to replay from time to time.

Behavioural elements

Behavioural elements refer to the player and the context of the game that make games essentially a human phenomenon. This refers to the co-located, multiplayer nature of board games, that inevitably results in social interaction.

In proposing a model of social interaction within multiplayer games, Jose Zagal [57] offers a distinction between interaction that is stimulated by the game, and that which is spontaneous and voluntary. A number of mechanics commonly implemented in modern games generate this kind of social interaction (e.g., auctions, negotiations, etc.). However, according to Woods [55], it is not this form of in-game interaction that players are describing when they cite the pleasure of social interaction in modern games as principle in their enjoyment, but rather the spontaneous interaction that occurs as a by-product of game play. The shared physical space and components have a profound effect on the nature of the game encounter.

Goffman calls the resulting effect "spontaneous involvement" [26] and describes three reasons why such involvement is significant. Firstly, the acknowledgement of shared focus provides a sense of security for all players. Secondly, it increases relatedness through mutual involvement. Finally, it confirms the reality of the shared world of play.

3.3 Players

Based on our findings we differentiate between two main type of players. Hobbyist and casual players. These two groups have different motivation to play and acquire new games, that we are going to discuss here.

3.3.1 Hobbyists

Hobbyist players actively participate within hobbyist culture. They are always up to date about new games. Games are often up for discussion in forums and blogs where they are being reviewed and rated by them to inform other members of the community. The most active members are often contributing in testing and discussing new board game designs.

One member describes them in the following way: "In some ways I think we're more like beer, wine, or scotch enthusiasts. It's fun to know about a lot of different games: how they're alike or different, how a game reflects its designer, publisher, and the era or country in which it was published. How well a game works with different ages, or with different numbers of players." [55]

There are several possible aspects that can work as motivation for these players to purchase or play new games. A few of them are listed here:

1. Several hobbyist interviewed by Woods [55] have a story about their nice experiences they had back with their families or childhood friends playing board games. These member are supposedly pursuing the ideal game experience how it was long time ago.

2. In the case of board game hobbyists, such identification as "the guy with the lot of cool games" can play an important role in establishing cultural capital within the community.

3. They experience games as others art or movies. They have a desire to engage in new gaming experiences, but games are only interesting for only a few times. Which is actually one of the characteristics of modern eurogames, that is going to be explained later.

3.3.2 Casual players

The other big group of players is the group of casual players. This group consists of all the people who have ever played with any kind of board game. For these people, board games are a way to pass a few idle hours without too much thought and effort. As a result, these people do not like to learn the rules of new games. As a matter of fact, the rules of board games have to be studied before they can be played. How many people would want to watch television if every single program would require interpreting and learning of a 20 minutes long manual to be able to enjoy? Sometimes these players even come up with their own rules to bridge the gaps caused by forgotten parts, to avoid rule book reading. As a result, according to the game designer Nick Bentley [11], these people have emotional attachment to games they have already played with. They generally talk about and play these games only. This spreads these games further and creates a tall barrier for entry for new games and that is why the total number of mass market success is low [11]. And that is also the reason why old traditional games like Monopoly, that has numerous bad design elements are still amongst the top selling board games.

Despite of this, as it was described in the beginning of the chapter, the popularity of board games have increased significantly in the last few years. People are picking up different games from outside of their comfort zone. And these people are not just hobbyists but also casual players [18]. Which is somewhat expectable if we recognise that almost all of the reasons introduced for this growth of popularity offers an easing solution for the rule learning burden. Eg. with the help of tablet versions and game cafes they can try games and learn rules easier than ever before.

3.4 Extended board games

While in the previous sections the main focus was on analogue board games, this section discusses what kind of digitally enhanced board games or similar relevant games are out on the market and how players use them. Furthermore, we also

present how light is currently used in board games.

3.4.1 Digital version of board games

Digital versions of ordinary tangible board games are continuously popping up in the app stores. While the ruleset of these games is identical with the tangible versions, they still provide a different experience. This can be derived from their remote nature, that is players play remotely with each other, or they can even play against the computer but in both cases without tangible components on tablets or smart phones. As a result, they lack the most significant source of pleasure in board games, the spontaneous involvement (Section 3.2.2), which is created by the shared physical space and components.

These characteristics also provide some benefits as it was discussed in Eric Hautemont's talk at Google [27]. Players are not looking at the same game board, so the interface can provide them helpful information that should be hidden from other players. In addition, the interface can also provide tutorials and help during the game. according to Hautemont digital versions are also played differently from tactical point of view. Normal board games create more emotional connection between players, that influences them. While playing the digital versions they have more time to think and much less influence on each other.

3.4.2 Blended board games

There are some commercial board games out on the market that use light in some way or have digital components. One classic example for that is the Operation game. Players have to use their hand-eye coordination skills to remove plastic ailments with a pair of tweezers without touching the edge of the cavity opening. In case of touching, they get a feedback in a form of light and sound.

Other examples for somewhat blended games are the products of Hasbro that are shaped for new generations of players. One of them is the electronic scoring version of the classic game Scrabble.[2]

[1]Images retrieved from http://www.terraintechgames.com/
[2]Electronic Scrabble http://www.hasbro.com/

Figure 3.2: Operation game by Hasbro with light feedback.

3.4.3 Room escape games

Room escape games are live-action, team games where players discover clues, solve puzzles, and accomplish tasks in one or more thematically decorated rooms, in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time [42]. Escape rooms tap into the desire for the social and the physical while also providing intellectual stimulation, just like board games. However, they do it in a rather immersive way by moving away from the table and putting the whole experience into a highly thematic setting. They are also referred to as real life board games. Room escape games have been getting a lot of attention since 2012, first in Asia, then across Europe (with Hungary being a significant hub), and then over to Australia, Canada, and the USA [42]. Their fast dispersion indicates a consumer inclination for games that offer new type of social experiences, by providing stimulation for an extended number of the player's senses.

3.4.4 Current usage of light

As we mentioned before, hobbyist players are highly active online. Thus, in order to find out how they use light in their gaming encounters, we tapped into their discussions on forums at BoardGameGeeks. The search function of the forum

Figure 3.3: Custom made board game table.[3]

found around 1000 results for the keyword "light". Amongst these results the following were somewhat relevant for our research. Most conversation on the forums that is related to light is about visibility issues on game nights. These game nights are sometimes held on specific venues that are not designed for these kinds of events. As a result, they often lack appropriate lighting needed for the gameplay. Components of board games can have text or different colours on them, that needs to be read or distinguished. According to the discussions, this is not always possible without appropriate lighting conditions.

Some of the players have special rooms that are appointed for playing board games. Discussions are going on about what kind of lighting to use to avoid glare, mixing of colours. These special rooms sometimes contain special furniture, like custom made board gaming tables. These tables usually have a vault on their edges, which prevents components falling down to the ground. The vault usually also equipped with LED strips from the inside to provide better lighting conditions, as it can be seen on image 3.3.

Figure 3.4: Custom made dice tower which adds to the ambience. Sometimes they also contain candles inside.[4]

There are also discussions about furnishing these rooms in special themes to create a fitting environment for board gaming activity. Although, these setups do not necessarily involve lamps, light can be a potential mean to create special and easily changeable ambience in a room. Another discussion that is related to special ambience is about custom made dice towers. Dice towers are used for rolling dice for players. Players customize these towers for their own taste. Some of the players put candles in these towers that can provide a really nice thematic ambience. One of these towers can be seen on Figure3.4.

Another findings are computer programs that provide sound effects for role play game sessions. This is also an indication that games that rely on imagination or guide players through immersive stories could benefit from creating thematic ambiences that fit the stories.

Finally, one interesting future product that is going to be released sometimes in 2015 is the Terrain Tech Power Grid[5]. The Power Grid is a large neoprene rubber mat that rolls out underneath miniature game terrains, and provides wireless

[3]Image retrieved from the Boardgamegeek forum `http://www.boardgamegeek.com`
[4]Image retrieved from the Boargamegeek forum `http://www.boardgamegeek.com`
[5]Terrain Tech Power Grid `http://www.terraintechgames.com/`

(a) Lighting components used to decorate a miniature world.

(b) Lighting components used with the pawns of a board game.

Figure 3.5: Usage examples of the Terrain Tech Power Grid

power to all of their game pieces, from torches to lasers, and even spinning motors. Although, it is originally for miniature games, it could be perfectly used for board games too. Some board game reviewer has already noticed the potential to combine it with board games [15]. It can be a great tool to provide immersive ambience or completely new light based mechanics in board games.

4

Framing the design space of light extended board games

In this chapter we outline the design space of light extended board games. Firstly, we explain the methodology we used to frame the design space. Secondly we introduce the design space, that consists of four main areas. In the scope of this project we will only focus on the combination of two of these areas. These are the augmentation of already existing board games and thematic ambience. Finally, we end this chapter by proposing three categories of roles that light could play in board games, along with introducing our concepts in two of these categories.

4.1 Methodology

4.1.1 Kick starter brainstorm sessions

As the topic of light extended board games is fairly unexplored, in addition to our background research we decided to involve extra people to help in broadening our horizon. Thus, we organized a brainstorming session with other interns from Philips Research and Design. On this session first we discussed our favourite board games, then chose three that was known by all the participants. After that, we brainstormed on possible roles light could play in these games in turns. While the outcome of the session was positive, it revealed some serious limitation for this method.

The set of games that all participants know is rather small. In addition, typically participants have not played these games for years. As a result, they were not able to recall the rules correctly. Based on this learning, a participatory method, where players could play games together and ideate during and after the play would be beneficial.

Although this concept of ideating in context is promising, it has some limitations too. The play time of a board game is minimum 20 minutes, but there are also examples that require more than 2 hours. In addition, these games have to be learned first of all, which also adds to the time. As the challenge of finding participants on campus in work time for such a session seemed really difficult, we incorporated the ideation in our ethnographic research. This was enabled with the help of our colleague Peter Lovei from Philips Design, who joined us to some of the game nights. On these events we tried several board games that we used for coming up with different light roles.

4.1.2 Ideation with mind maps

The method we used for organizing and framing the design space for light extended board games was mind mapping. A mind map is a diagram used to visually organize information. A mind map is often created around a single concept, drawn as an image in the center of a blank landscape page, to which associated representations of ideas such as images, words and parts of words are added. Major ideas are connected directly to the central concept, and other ideas

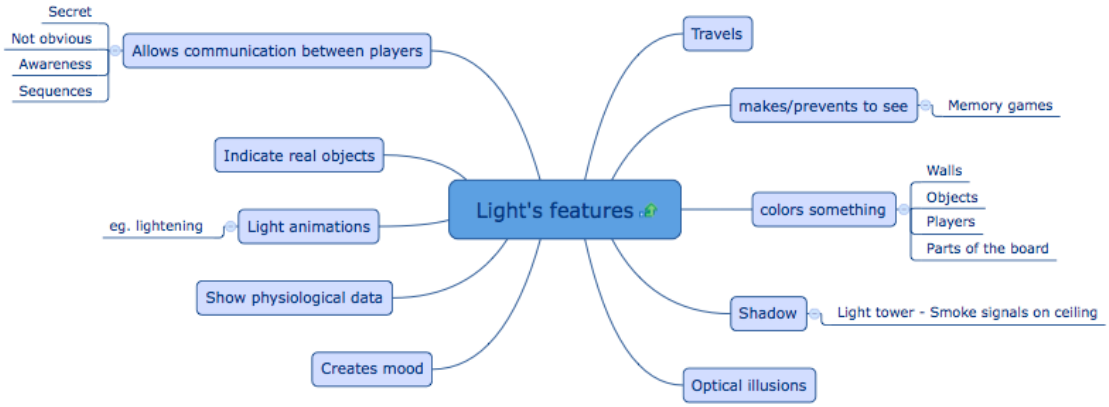

Figure 4.1: An example of the created mind maps. This represents some of the features of light.

branch out from those. Mind maps can be used to generate, visualize, structure, and classify ideas, and as an aid to studying and organizing information, solving problems and making decisions.

The method consisted of visualising all the collected information on small mind maps on a single sheet, which can be used to generate new mind maps. Some of the mind maps created are the followings:

- Important design decisions in board games: This consists of the bad design decisions (Section 3.2.1) in classical board games and elements related to player enjoyment.
- Features of light: This includes characteristics of light that could be used in board games and also possible means of using light in board games such as indicating real objects in the room or offering secret communication for players.
- Types of lamps: This consists of different types of luminaries that could be used for board games such as in gloves, in tiles, on the board, illuminating players.
- Features of digital games.
- Interesting board games dynamics.
- Ideas about what to visualise by light.

The result of this process is a huge canvas of mind maps with numerous concepts that light could play in board games. These concepts can be categorized into four groups that form the design space of light extended board games, which is going to be described in the next chapter.

4.2 Design space

Based on the information that was gathered on our background work that consisted of literature research, market research, ethnography and ideation sessions, the design space has been framed with a result of four areas, which are introduced in the followings.

4.2.1 Existing board game augmentation

The existing board game augmentation area refers to ways how light can be used to augment already existing board games without significantly changing the nature of these games. This can consist of changing different game elements by lighting solutions, or replacing original mechanics by new ones based on light. Our ideas in this area consist of augmentation concepts of several existing games and a set of separate concepts that could be used in general to enhance board games.

4.2.2 Extended game space

The extended game space area was motivated by room escape games. As it was mentioned before (Chapter 3), the fast dispersion of these games, indicates a consumer inclination for games that offer new type of social experiences, that provide stimulation for an increased number of senses. As a result, the extended game space area explores how to use light to take board games away from the table by incorporating the whole room or apartment and real objects in them. Extending the game space to a room or even to the full apartment would significantly change the nature of board games. Playing the game apart from a table requires new type of challenges that infer new type of interactions.

4.2.3 Remote play

The area of remote play refers to solutions with light that can enhance playing board games remotely. It is motivated by tablet versions of board games that can be played remotely (Section 3.4). Nevertheless, this area stayed rather unexplored, as co-locatedness turned out to be one of the most important characteristics for the enjoyment of board games. Still one benefit recognised over already existing remote board games is the possibility of incorporating "seamful" design [19]. Seamful design suggests to accept and make use of the limitations of technology. In the sense of games, it can be used to create challenges around limitations as it is suggested by Magerkurth [39] too. In remotely played games, one serious limitation is the lack of co-located game space. While recreating the same spontaneous involvement created by the co-located aspect of normal board games seems impossible, it may offer better means of indicating remote player moves. Instead of turning an existing board game into remote, as it is usually done (currently mostly in tablet versions), new games could be designed with the goal to create a remote game. In these games the remoteness of players could be used as a benefit. Embedded lighting in the board could be used to visualise vague information about the remote players, which should be interpreted by the co-located and used to pursue the goal of the game.

4.2.4 Thematic ambience

As it was mentioned earlier (Section 3.2.2), most of the modern board games' rule systems are tightly coupled with themes. These themes can function to draw players into the fictional world of the game and thus enhance the players' experience. The goal of this area is to explore the way of enhancing or creating new games with incorporating thematic ambience. This area is also motivated by the special environment of room escape games and by our findings about how hobbyist players sometimes create special environment for their gaming encounters (Section 3.4). While this group could also be a part of all the three previously discussed area, it was still handled separately as a result of its broadness.

4.3 Focusing the design space

During the exploration of these areas, numerous concepts has been set. However, there was a need for focusing the design space. Firstly, the remote play area was eliminated, since this area falls the furthest from board games concerning the game experience, as a result of its non co-located aspect.

While we have some promising concepts in the extended game space area, most of them are only separate game mechanics without a containing ruleset. Although, the usability of the new mechanics could be tested, - e.g. if a concept of using light for indoor navigation works - the effect of these concepts on the gameplay experience is impossible to determine without a whole game. In order to design a new game and containing rule set, further exploration of the area of space extended social games is necessary.

As the main focus of the work has been on board games, it is imperative to focus the rest of the research on the augmentation of already existing games along with the themed ambience area. The set of concepts in these areas includes both solutions by normal bulb base lighting and solutions that should be embedded in the components of the games. As Philips Research is mainly interested in the alternative uses of the Philips Hue system, this thesis focuses on solutions with bulb based lighting in the followings.

4.4 Roles of light in board games

Based on our studies and observations on board games, we propose three main categories of possible roles that light could play in board games. These are ambience support, gameplay elements and game tools. These roles have already been shortly explained in the introduction of this thesis, as they also form my research questions. Here I will also introduce the most promising role concepts of the focused design space in two of the three categories. These concepts are going to be evaluated, which is going to be described later in Chapter 6.

4.4.1 ambience support

The first role is the ambience support that is mainly used for decorative purposes to create theme dependent atmosphere and in this way support immersion. This category is based on the concepts of the themed ambience area of the design space. In football, ambience is the sound of the audience and the weather conditions.

Thematic ambience

As it was described in Chapter 3, there is growing popularity of new wave board games with tightly connected themes. The application of these themes to the mechanics and goals, while not strictly necessary, serves to make the games more readily understandable, and also provides the players with a role around which their actions within the game can be contextualized. As a result, themes can function to draw players into the fictional world of the game and thus enhance the players' gameplay experience. By creating thematic lighting that fits the game's theme in the room, the goal is to create a special atmosphere in order to enhance the gameplay experience.

Interactive light effects

Interactive light effects are used widely in television quiz shows or in other digital but physical games for example in laser tag. These effects are usually used as feedbacks of player actions, indications of game status or just for decoration. The goal of this concept is firstly to provide adequate feedback for player actions and secondly to do that in the theme of the game in order to add to the atmosphere created by the thematic ambience.

4.4.2 Gameplay elements

The second type of roles are gameplay elements that host game state information and support rules. As an example, in football the score table and the judges are gameplay elements. In addition to this, ambience support can also be used in connection with gameplay elements to provide information for players in the theme of the game, that is necessary to achieve its goals. For example in a game, where the fearfully blinking thematic lights correspond to a situation when the user needs

to take an action in order to defend herself from approaching Indians.

Thematic indications

In analogue board games, random elements that change something on the normal gameplay are usually based on luck. Dice are rolled or cards are drawn to see what is going to change in the game. With the help of digital augmentation, different thematic light effects can be used to indicate these elements. As new wave board games tend to be thematic, thematic indication of these elements can be beneficial in enhancing the immersion of players.

This and the previous two ambience support roles can also be related back to the project introduced in the related work (Chapter 2), where visualisation provided by projections reportedly enhanced immersion of the players [2]. However, in this project, instead of providing visuals only on the board, my goal is to create a thematic atmosphere in the room by providing visuals also around the players.

Randomly triggered gameplay elements

As it has been already mentioned at the thematic indications, random elements are usually triggered by drawing cards or rolling dice. Thus, these elements are triggered by human intervention. By visualising these elements by thematic light effects (thematic indications), they can be also triggered automatically in random moments. These random gameplay elements would usually be random in the real world too, just like weather condition changes that cause difficulties in normal everyday activities. Thus automatically triggering them in random moments would turn them into real world metaphors. While this concept might reduce player effort by the automation, one possible limitation is if it happens on the expense of enjoyment just like in Wallace's work [53], which was discussed in Section 2.3.

Thematic timer

Sometimes timers are used in board games for timed tasks. These are usually egg timers that have to be started and paid attention to by players. By enhancing board games digitally, these timers can be automatic and thematic light effects can be used to visualise different phases such as preparation for the task, starting the task, passage of time and end of the task. Thus, the goal of this concept - just like

the previous one's - is to reduce player effort, but in an immersive way by embedding timer feedbacks in thematic light effects.

Challenge caused by special light condition

With the help of light, special environment can be created which can give room for different challenges. For example it can be used similarly as cards in pattern recognition games. Different colour cues can be shown that the players have to recognise. Or special light condition can be created to make a task more difficult to solve. Challenges of board games are usually based on the combination of strategy and luck. However, to solve these challenges caused by light conditions, players have to use their skills too. Thus, light can be used to mix skills amongst strategy and luck. There are different party board games where the challenge is set by tasks that require specific skills to be resolved faster or more accurately than other players. However, these different types of challenges have not really been combined in board games. The possibility of combining these kinds of challenges with the help of digital technology has been also recognised in Narahara's work [41], which was discussed in Section 2.3.

4.4.3 Game tools

The third type of roles are game tools, that users can directly interact with and change their state. Their usage is necessary to achieve the goals of the game. In football an important game tool is the ball. Nevertheless, this direct interaction is not limited to direct physical interaction, but can also include direct remote interaction, such as the ball can be remotely floated using a smart drone. The usage of light as game tools has the potential to create new game mechanics and as a result, new types of games. Although these elements are really promising, unfortunately they have not fit into the scope of this project. They will remain for future work.

5

Designing and developing a light extended board game prototype

This chapter discusses the design and development of our light extended board game prototype. In the end of the previous chapter, 6 light role concepts have been introduced. In this chapter we explain how we mapped these concepts into the context of an existing board game, which resulted in new rules and corresponding light effects. Finally we close the section by introducing our Android interface that controls the designed light effects.

5.1 The context

According to Stenros [49], designing a game always means designing an activity. The game's rule system must provide a platform for a meaningful activity. Accordingly, games are bundles of rules and mechanics that work together to provide pleasurable gameplay experience. As a result, to be able to test the previously introduced roles of light, each role should be mapped into the context of a game.

5.1.1 The chosen game

The game that was chosen for this role, is the dice version of Bang![1]. The play time of this game is only 15 minutes and according to boardgaming.com, the learning curve is just 5 minutes. While the game has a high luck factor - which is usually disliked by hobbyist gamers - it has quite high rating (7.11/10) on the most famous portal - boardgamegeek.com - amongst hobbyist. In addition to this, I have also met this game on 4 out of 5 board game events. So the reason why I chose it is because it is short, easy to learn, popular amongst different types of players and not the least, its structure provides room for different types of extension with interactive lighting.

Original rules for 3 players

At the start of the game, players each take a role card: the Deputy, Outlaw, and Renegade. The Deputy needs to kill the Renegade, the Outlaw wins by killing the Deputy, and the Renegade wants to kill the Outlaw. Each player also receives a character card which grants him a special power in the game.

On a turn, a player can roll five dice up to three times, using the results of the dice to shoot neighbouring players, heal his (or anyone else's) life points, or put him in range of the Indians, which are represented by nine tokens in the center of the table. Each time a player rolls an arrow, he takes one of these tokens; when the final token is taken, each player loses one life point for each token he holds, then the tokens are returned to the center of the table.

[1] Bang the dice game `https://boardgamegeek.com/`

Figure 5.1: Bang the dice game.

If a player collects a trio of Gatling symbols on the dice, he fires one shot at everyone else and rids himself of Indian tokens. The player who first eliminates his target, wins the game. (More detailed rules can be found in the appendices.)

5.2 Light setup

In the previous chapter (Section 4.4) we proposed 6 types of role concepts in the ambience support and gameplay element categories. In this section we are going to present our light setup that is needed to visualize the light effects of each concept. The setup (Figure 5.2) consists of 9 wirelessly controllable Philips Hue lamps. The light effects and corresponding rules are going to be explained in the next section (Section 5.3).

5.2.1 The desk lamp

The desk lamp has two functions. Firstly, it illuminates the play area which is in the middle of the table. In order to focus its beam more onto the middle of the table, we also equipped it with a plastic tube. Secondly, this lamp also serves as a game status lamp. As long as it shines in the same yellow colour, the normal

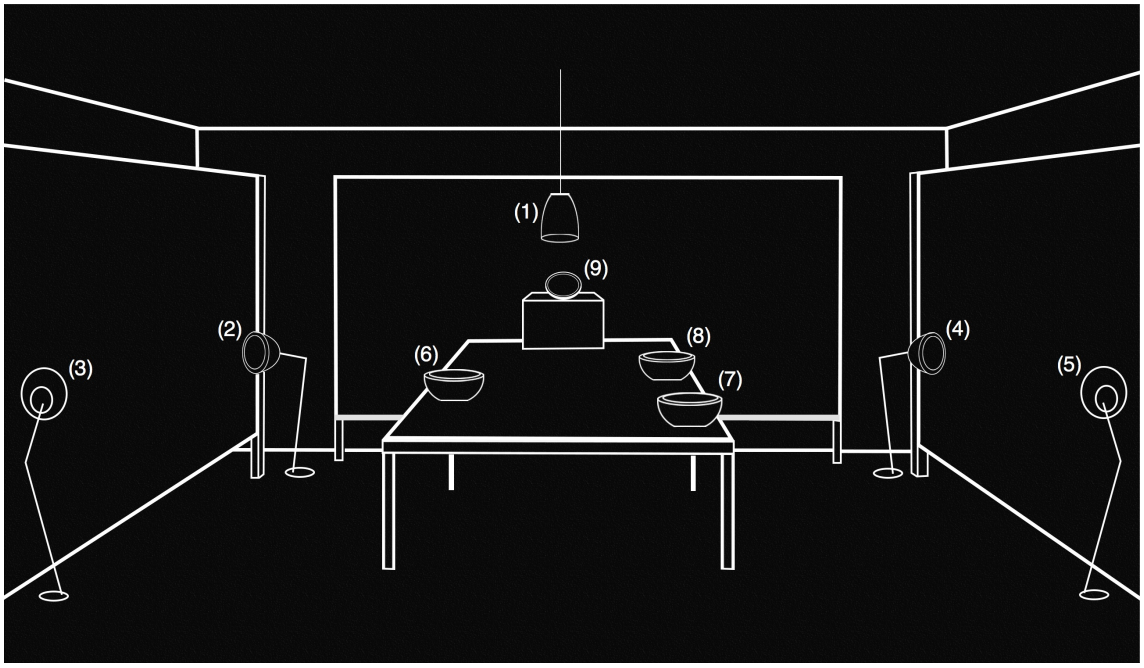

Figure 5.2: A special light setup has been established for the game: (1) desk lamp; (2,3,4,5) ambience lamps; (6,7,8) individual lamps, (9) sun lamp.

gameplay can continue. As soon as its colour changes, the normal gameplay is extended by additional tasks.

5.2.2 Individual lamps

Each player has an individual lamp. These lamps are portable Hue Gos[2], that are placed on the table in front of the players. These are used to show individual light effects related to life level and player actions.

5.2.3 Ambience lamps

The four ambience lamps around the players are used to create a fitting environment for the game's theme. The players are sitting along the two longer sides of the table, that can be seen on Figure 5.4. In the room, that facilitates the test, walls are differently coloured on both sides. As a result, by illuminating the two differently coloured walls, players on different sides of the table would

[2]Hue Go `http://www2.meethue.com/`

Figure 5.3: Individual lamps are placed around the gampeplay area, that is illuminated by the desk lamp.

experience the light effects in different ways as a result of the reflection from the walls. In order to provide same conditions for all the players, two boards covered by white fabric sheets are placed behind the players on both sides. Each board is illuminated by two lamps from their two sides. In this way, players can enjoy light effects with same brightness, hue and saturation.

An additional Hue Go is placed on a box on the table next to the wall. The role of this lamp is also ambience support. It represents the sun and the moon, during the game.

5.3 The light effects and corresponding rules

While in the previous section we presented our light setup, here we are going to map the 6 concepts (Section 4.4) into the context of Bang! the dice game. We will explain the light effects we designed for each ambience support and gameplay element roles and how they are connected to the rules of the game.

Figure 5.4: The four ambience lamps and the sun lamp are placed around the players.

5.3.1 Ambience support effects

ambience support elements are mainly used for decorative purposes to create theme dependent atmosphere and in this way support immersion. In the previous chapter (Section 5.3) we introduced 2 ambience support concepts, namely the thematic ambience and the interactive effects.

Thematic ambience

We designed a static thematic ambience for the game which is supposed to create an immersive atmosphere in the room that is tightly connected to game's theme. This static light effect consists of yellowish light on the ambience lamps and sun lamp, red light on the individual lamps and also yellowish light on the desk lamps that illuminates only the gameplay area.

Interactive effects

Our second ambience support concept is interactive effects. The main goal of our interactive effects firstly is to provide feedbacks of user actions. Secondly these feedbacks are visualised by thematic light effects that aim to enhance immersion.

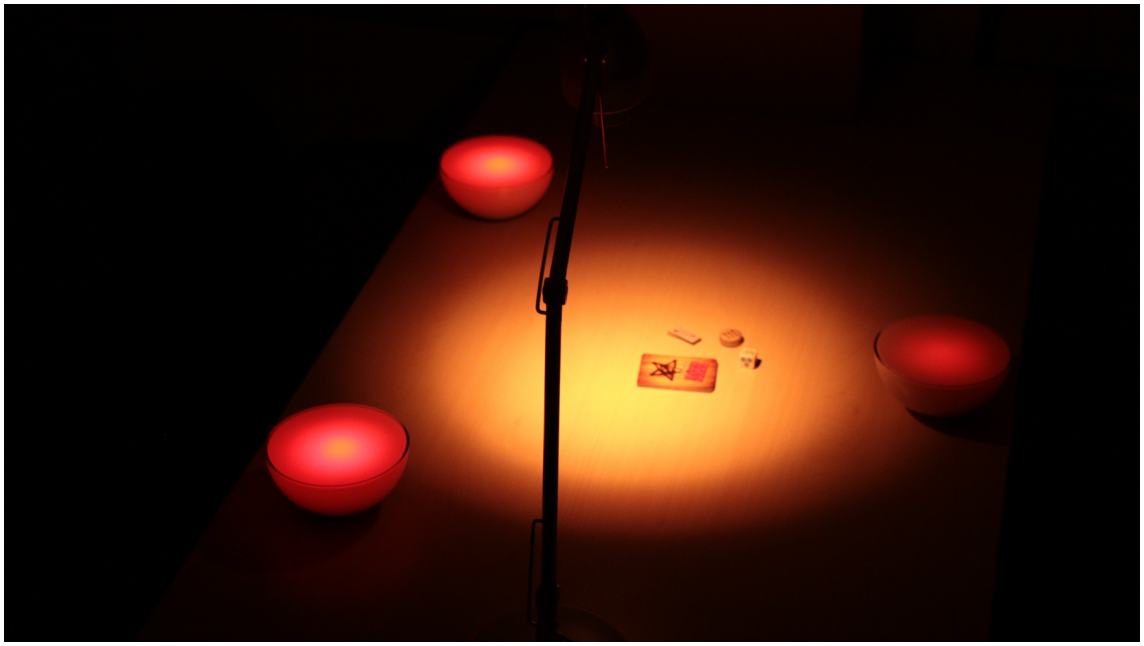

Figure 5.5: The bottom right player has less life points than the other two, which is indicated by lover brightness on her individual lamp.

We designed 3 interactive effects for the game that are visualised on the individual lamps in front of the players. These are the life point visualisation, shot and arrow effects.

Life point visualisation

In Bang!, players shoot at each other to cause harm to and eventually kill their enemies. In the original game life points are indicated with bullet coins. If a player gets shot by another one, he loses one bullet coin, and dies in case of losing his last one. According to this concept, life point levels of players are indicated on the individual lamps. The lamps show a constant red colour, but their brightness changes according to the amount of life point they have. Brighter red light corresponds to higher life levels, and lower brightness to the lowers. In case a player has only 2 or fewer life points, a heart beat animation will start to indicate the danger of death/losing. In this way, raising some excitement.

Presumably this way of life point visualisation cannot show the exact number of life points a player has. Thus life coins are still used in the game and the life point visualisation only serves as ambience support, rather than a gameplay element.

Shot effect

According to our observations, most of the players shoot others in the following way: they grab the dice that they can use for shooting and put them in front of the players they want to shoot. This movement can be seen as aiming a weapon on the victim and pulling the trigger when putting down the dice. The idea is to really make this movement feel like shooting on another player. This is done by playing a shot effect on the victim's lamp at the moment the dice are touching the table. The effect consists of a yellow flash on the targeted player's individual lamp (Figure 5.6). In a final product players could have own smart plates where rolling and resolving dice would happen.

This effect can also be interpreted as a feedback of losing a life point. Change in the brightness of the corresponding individual lamp happens right after the shot effect.

Arrow effect

When the last arrow is taken by a player from the middle of the table, the Indians attack. This is visualised by the arrow effect, that consists of a few blue flashes on all the individual lamps (Figure 5.7). The blue colour is chosen as the arrow tokens are bluish. Thus, keeping the consistency between the light effects and the tangible parts.

5.3.2 Gameplay element effects

Gameplay elements host game state information and support rules. The design of the gameplay element effects into the context of Bang! included the design of three new extensional rules. During the design of the new rules, learnings of the background research and game heuristics [22] have been kept in mind. It should be noted that the goal of this prototype is to test the chosen light role concepts and not to design a perfect board game. As a result, some of the rules may not reflect adequate design decisions for a replayable game. It only serves experimental purposes. However, these rules will still serve well for playing the game a few times on user tests. Possible limitations of the rules are going to be explained shortly

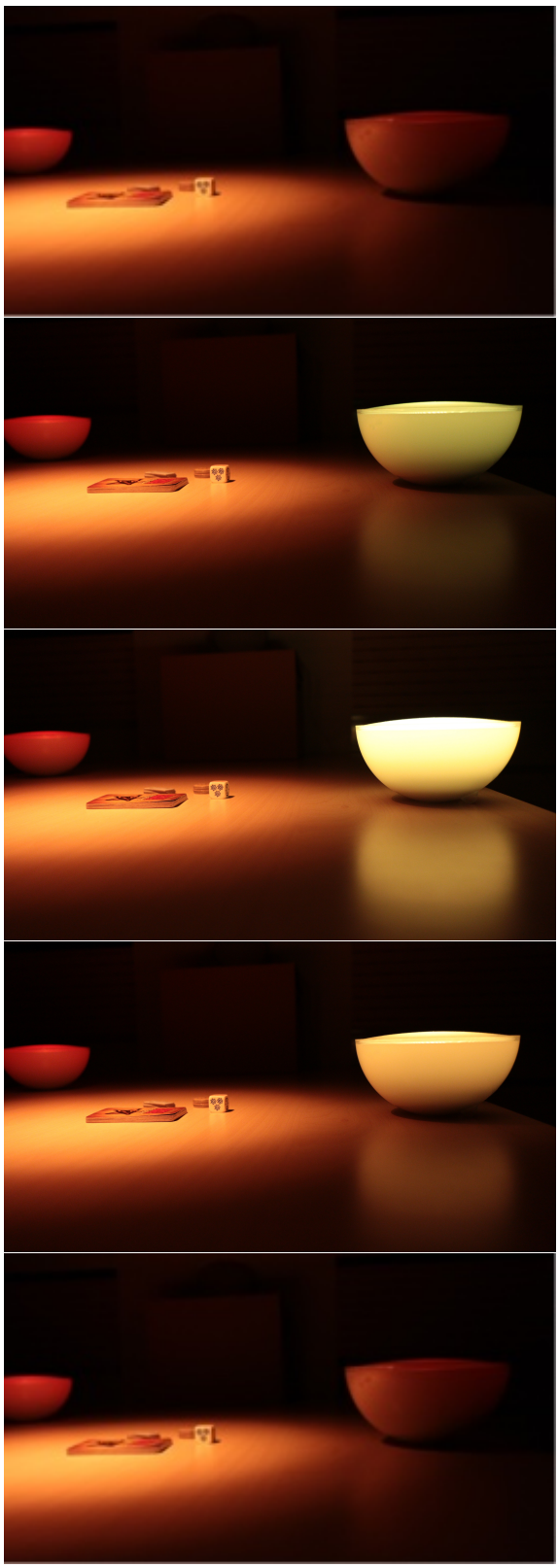

Figure 5.6: The shot effect consists of a yellow flash on the targeted player's individual lamp.

Figure 5.7: Indian attacks are visualised by blue flashes on the individual lamps.

along with their introduction.

Regarding the corresponding light effects, mostly Nielsen's 10 Usability Heuristics for User Interface Design [43] were applied. The most important guidelines followed were the followings:

- Light effects should be simple to allow easy recognition. They should not carry important information to be perceived, as it is difficult to remember and interpret [28].
- Light effects should be easily distinguished from each other.
- Light effects should be as consistent with the original game as possible.
- Colours and different lamps used should provide an obvious representation of the game elements.

All three extensional rules, namely the sand storm, night and Indian attack include more then one gameplay element concepts. In the following we are going to explain the rules with the corresponding concepts and light effects. In the text we indicate each concept by italicizing them.

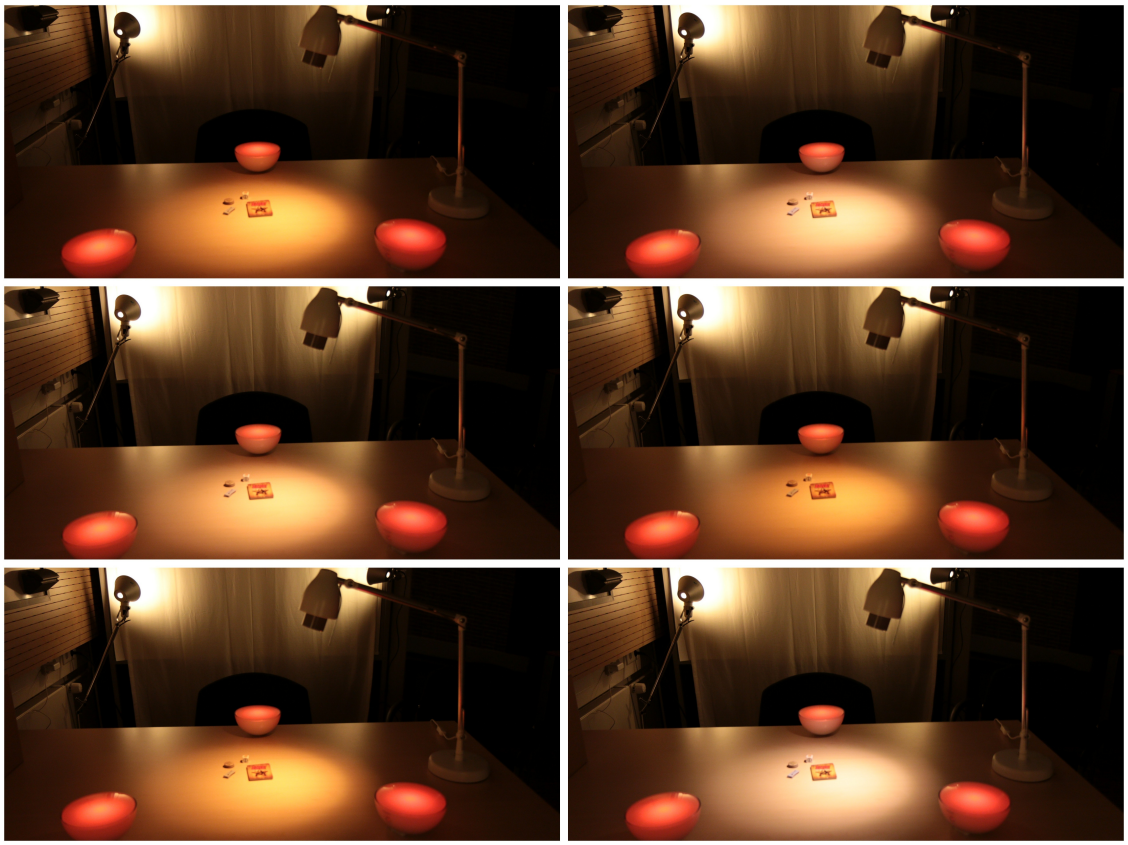

Figure 5.8: The sand storm is visualised by waving yellowish lights on the ambience lamps and flashing yellowish lights on the desk lamp.

Sand storm

Sand storm is firstly a *thematic indicator*. Thus it is visualised by a slowly waving yellowish light effect on the ambience lamps and flashing yellowish lights on the desk lamp (Figure 5.8). The changed behaviour of the desk lamp, does not only serves as a thematic indicator, but as it was explained earlier (Section 5.2.1), it also indicates a change in the game state.

Sand storm also a *random element*, which means that it happens unexpectedly just like in the real world. Furthermore, the activity that it entails, is also framed in real world context. That is, sand storm creates bad visibility condition. Thus when a sand storm happens during a player's turn, the other two players has to mix their character cards faced down on the table. In case the current player is planning to shoot someone, he has to choose his target from these cards. As a result, he cannot be sure about who he is shooting.

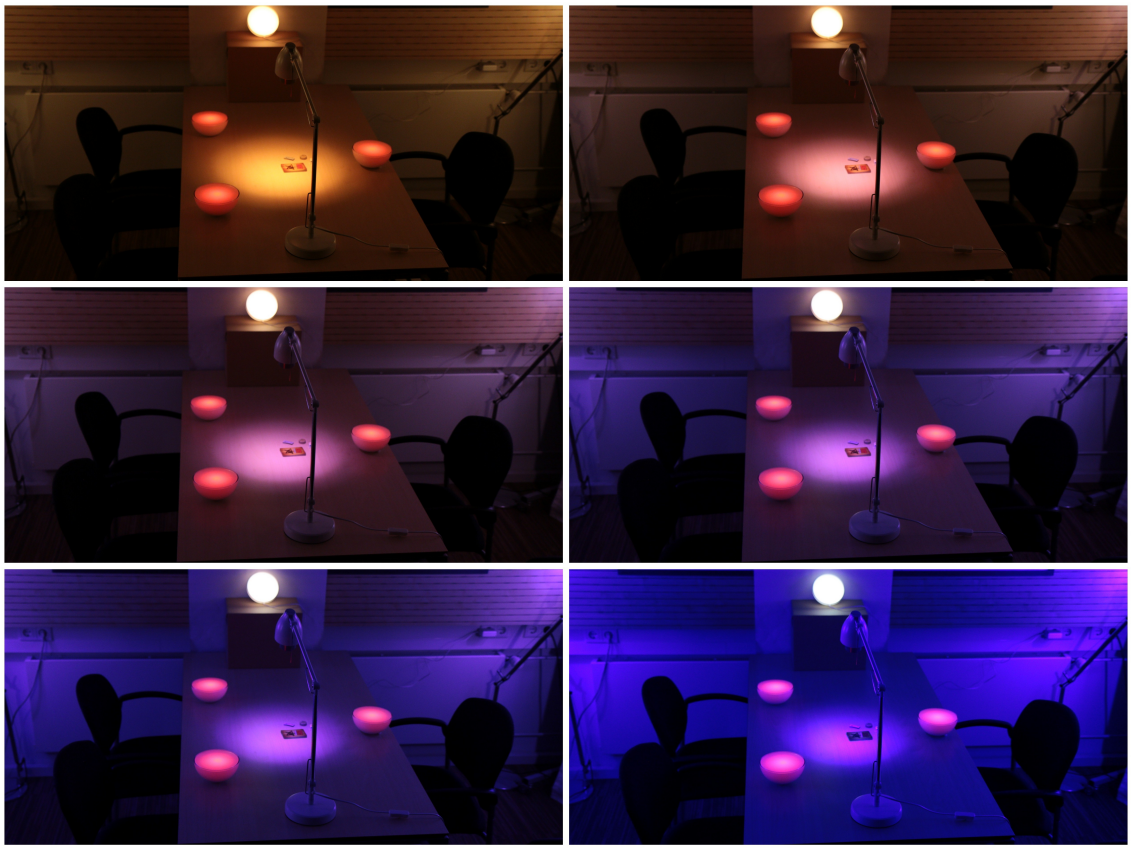

Figure 5.9: The preparation phase indicates the approach of the night.

Night

The night is a *thematic timer* which has three phases: preparation, sunset and sunrise. It happens in every two rounds. The preparation phase indicates the approach of the night. This is visualised by slowly fading in blue lights from the sun lamps direction on the ambience and the desk lamps, while the sun lamp turns into white from the original orange colour to visualise the moon (Figure 5.9). The new colour of the desk lamp again indicates a change in the game state.

The night rule is also a *challenge caused by special light condition*. This light condition is the darkness. According to the rule, in every two rounds the night comes and players get a chance to rob the bank. They can do that by using their fingers' sensing skills in the dark to grope out the key of the safe. The key of the safe is the combination of five different sides on all the five dice. All five dice have the same six hollowed figures on their sides. In the preparation phase, each player grabs a bag of five dice (Figure 5.10).

Figure 5.10: In the preparation phase, each player grabs a bag of five dice.

In the sunset phase, slowly all the lamps turn off (Figure 5.11). When the last lamps is off, players can pour out their five dice on the table and start to find different sides on each dice. Players have 20 seconds for that.

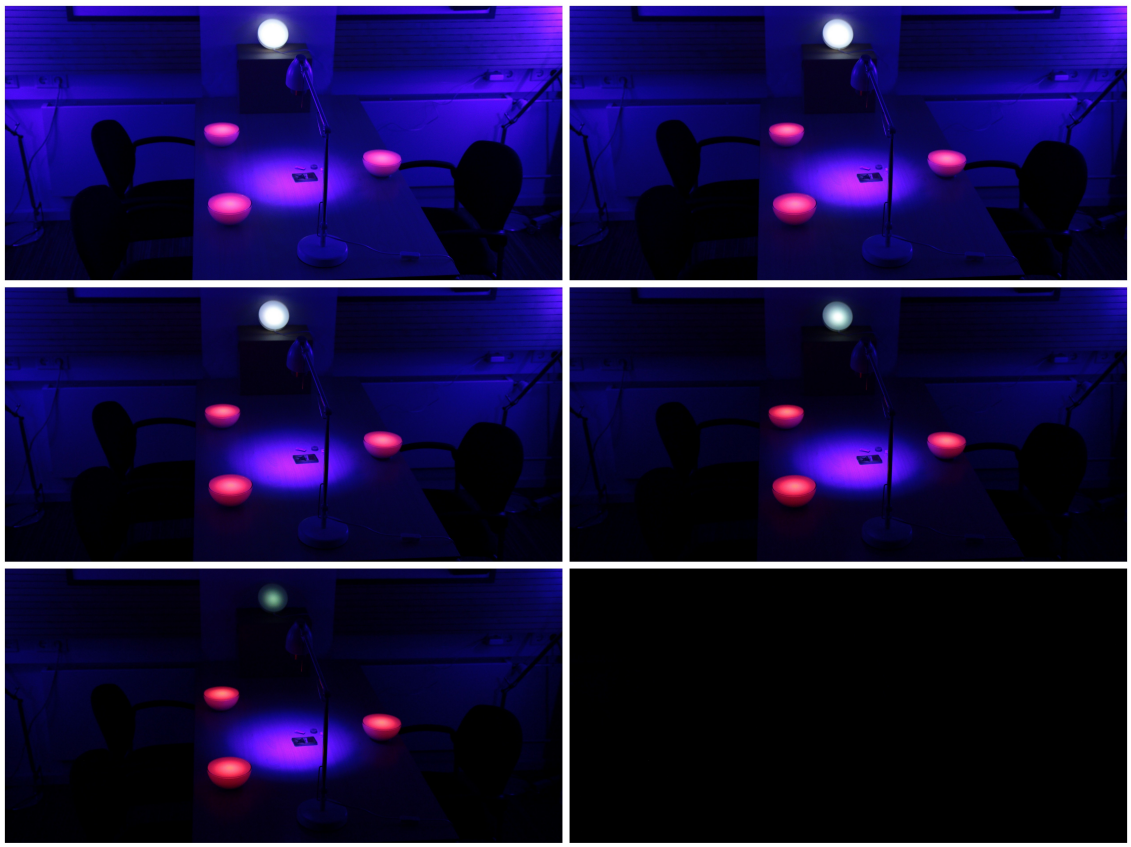

Figure 5.11: In the sunset phase, slowly all the lamps turn off.

After 20 seconds, the sunrise phase comes and as a result, all the lamps turn back on (Figure 5.12). By this time, players should have all the five dice down on the table with each of them on a different side. In case they managed to do this, they have found the key for the safe and thus succeeded in robbing the bank. These players earn two life points. Players who still have dice in their hands when the sunrise effect starts, are caught by the guards, thus lose one life point. Players who did not manage to find the key but have all their dice on the table have successfully left the bank before the guards arrived.

As the task in this rule is always the same, this is not necessarily a viable rule for a good, replayable board game. However, as it was mentioned before, the aim here is not to design the perfect game but to evaluate the concepts.

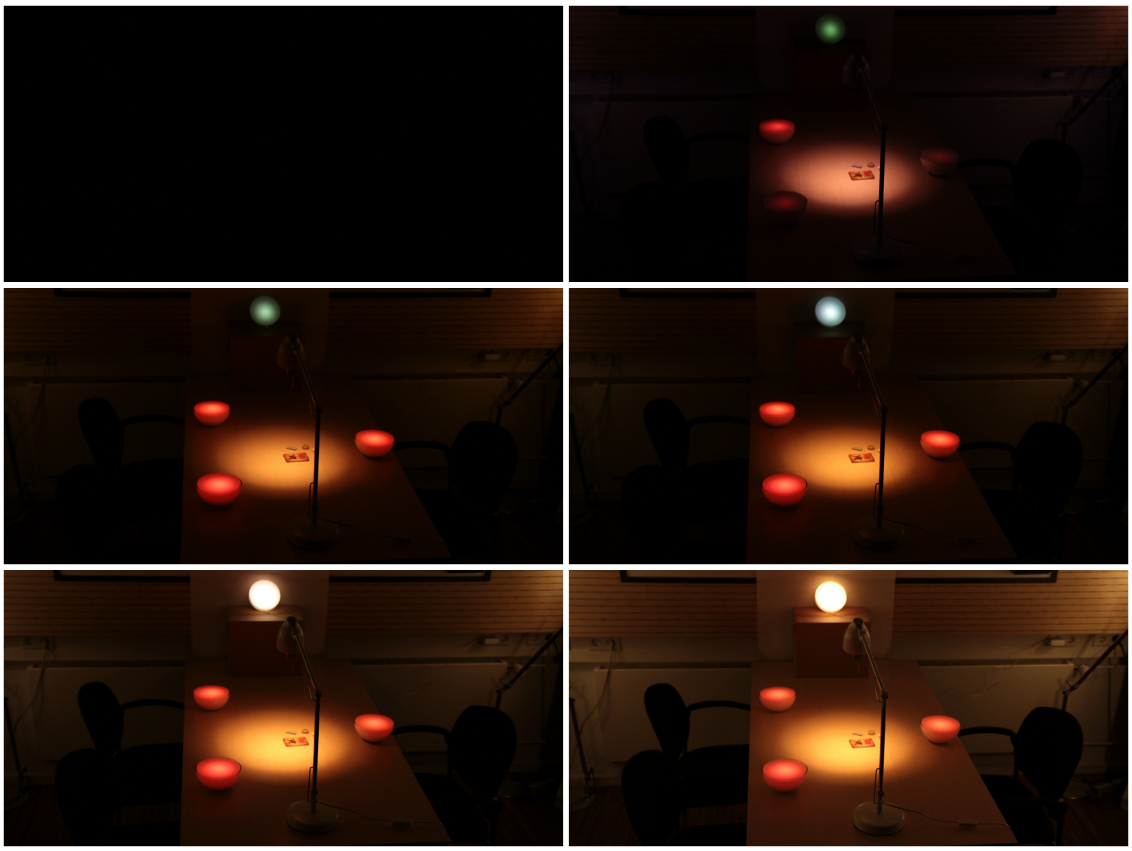

Figure 5.12: After 20 seconds, the sunrise phase comes and as a result all the lamps turn back on.

Indian attack

The Indian attack consists of a *thematic indication*, a *randomly triggered element*, a *thematic timer* and a *challenge caused by special light condition*. In the original game, when a player takes the last arrow from the middle of the table, players suffer from an Indian attack. This new rule gives an opportunity for the players to fight back the Indians.

Indians can be defeated by rolling dynamites on all of the dice. One player can only roll one dice at a time. Players can also resign from the task if they have no need to fight the Indians. Indians are visualised by purple colour and their arrows by blue. As it was mentioned when introducing the arrow effect, blue colour is used to indicate the arrows to maintain consistency with the original game that has arrow tokens with blue arrows.

When there is fewer than five arrows left in the middle of the table, there is a chance, that the Indians are coming. As it is a *randomly triggered gameplay element*, Indians can come in any moment. Players in the best scenario, have 37 seconds to fulfil this task. There are five phases of an Indian attack. As this rule also consists of a *challenge caused by special light condition*, the Indian attack light effects are really subtle in the first two phases. The players should recognise that the Indians are coming as soon as they can, as the sooner they recognise it, the more time they have to fight. All five phases of an Indian attack have different light effects, that supposed to visualise the passage of time. These are described in the followings.

1. 1st Observation phase: Indians start to observe the players. Short purple flashes appear on the ambience lamps around the players, in random moments and on random lamps (Figure 5.13). If the players recognise these, and any of them decides to start fighting back the Indians, the current player's turn stops and the players can start the fight. This phase takes 8 seconds.

2. 2nd Observation phase: In this phase the light effects are longer. Purple light appears on one lamp and disappears on an other (Figure 5.14). Still in random moments and on random lamps. Only the animation is fixed. If the players recognise these, and any of them decides to start fighting back the Indians, the current player turn stops, and the players start the fight. This

Figure 5.13: In the 1st Observation phase (1st Indian phase), short purple flashes appear on the ambience lights around the players.

Figure 5.14: In the 2nd Observation phase (2nd Indian phase), purple light appears on one lamp and disappear on the other.

phase takes 8 seconds.

3. 1st Fight phase: The Indians arrived and ready to attack. Both the desk and ambience lamps turn into constant purple light (Figure 5.15). The changed light of the desk lamp indicates the change of the game state. The ongoing round stops and players have to start fighting the Indians if they have not yet done so. This phase takes 5 seconds.

4. 2nd Fight phase: The Indians start their attacks. This is indicated by faster, more saturated purple blinks on the ambience lamps around the players, in random moments and on random lamps. This phase takes 8 seconds.

5. 3rd Fight phase: The Indians start to shoot with their arrows. This is indicated by blue flashes on the ambience lamps around the players in random moments and on random lamps (Figure 5.16). This phase takes 8

Figure 5.15: In the 1st Fight phase (3rd Indian phase), both the desk and ambience lamps turn into purple light.

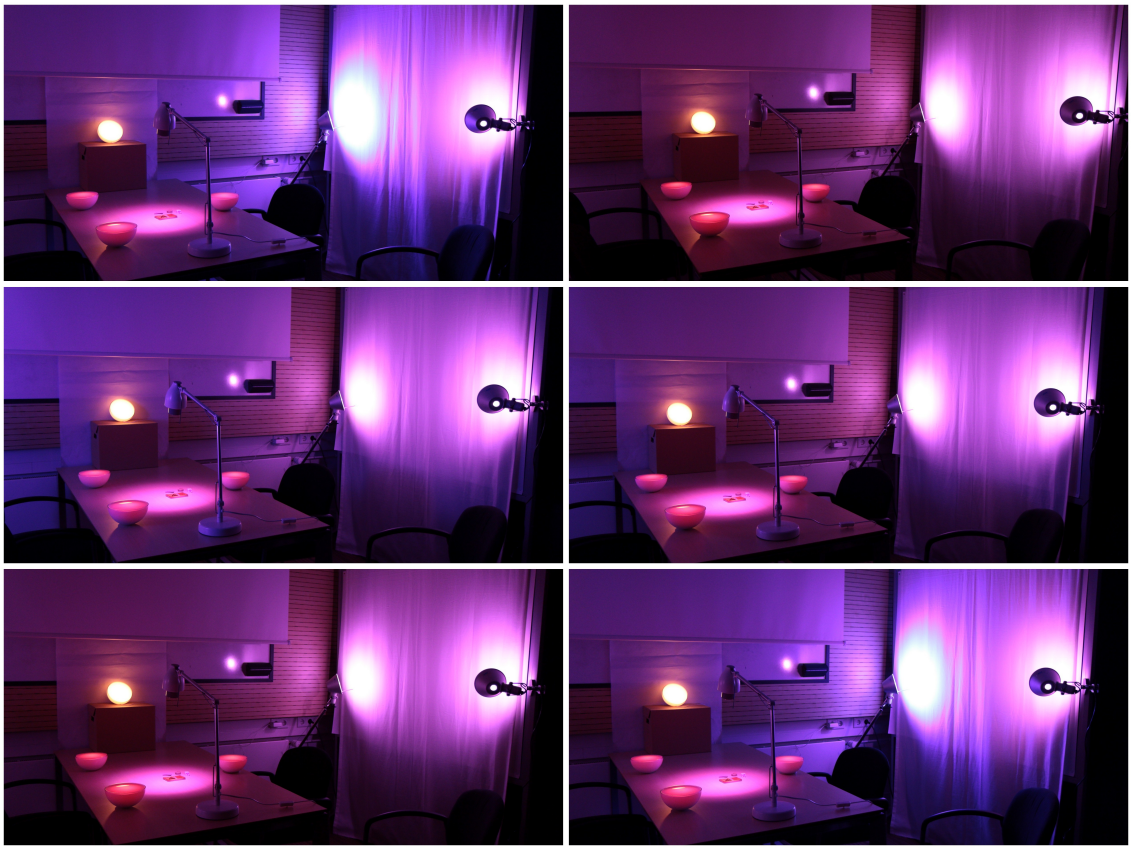

Figure 5.16: In the 3rd Fight phase (5th Indian phase), the Indians start to shoot with their blue arrows, which is indicated by blue flashes.

(a) In case the players are not successful, the Indians defeat them, which is indicated by the arrow effect.

(b) If the players collect the 5 dynamites, they defeat the Indians and the dynamite effect is played.

seconds.

The rule ends with either an arrow or dynamite effect, based on the outcome of the fight. The arrow effect consists of blue flashes (indicating blue Indian arrows) on the individual lamps, while the dynamite effect consists of red and orange flashes on the ambience lamps around the players. While the arrow effect is an interactive effect that indicates the success of the players, the dynamite effect is the stop feedback of the Indian rule's *thematic timer*.

After the fight, regardless the Indians or the players won, every player can return two arrows and the normal turns continue by restarting the player's turn whose turn was stopped at the start of the battle. Similarly to the original Indian attack rule, in case of being defeated by the Indians, all the players lose as many life points as many arrows they had in front of them at the moment.

5.4 The controller

Instead of developing a fully functional prototype that can automatically log the gameplay events, we decided to use the Wizard of Oz method [35]. This means the gameplay is observed by a facilitator, who controls the light effects manually on a mobile phone interface, based on his observations. Meanwhile, players still experience the game as a fully functional prototype. In this way the development of the prototype was faster and it provides more flexibility over the light effects, as a result of the manual control.

The light effects and the controller was implemented with the help of the Philips

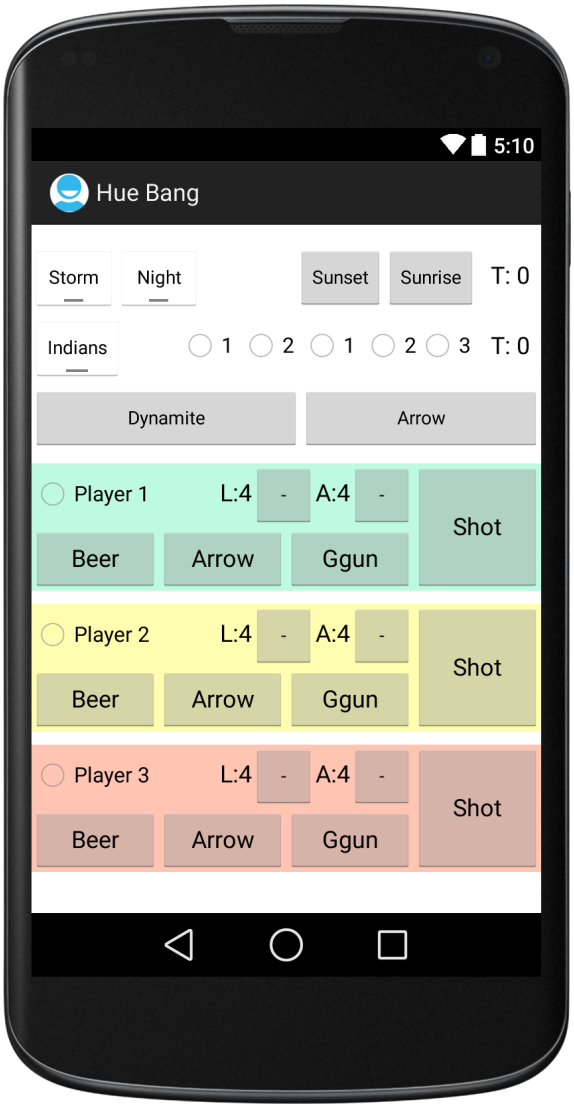

Figure 5.18: Android controller application.

Hue Java API[3], and the interface (Figure 5.18) was designed and implemented as an Android application.

One of the main guidelines when designing the controller was flexibility. This flexibility in practice means, that the light effects should be as much controllable as possible. There are two reasons for that. Firstly, two of the extensional rules rely on time limits. To determine the suitable length of the time limits, a pilot test was conducted. The goal of this test was to see how the players preform the tasks under authentic gameplay conditions. To be able to do that, time limits and

[3]Philips Hue API `http://www.developers.meethue.com/`

corresponding light effects had to be flexibly changeable to adapt to player performance. Tasks were also tested out of context before the pilot, however people preformed them much faster in authentic conditions.

Secondly, as board games are social phenomenons, no two board game sessions are the same. The games have different players with different moods, who use different strategies and there is of course also a luck factor during the game. As a result, every game session is a new challenge for the facilitator too, as he has to control the effects based on the always different gameplay. He can be surprised or can make mistakes, but he must be able to recover from these confusions as soon as possible to avoid the distraction of the gameplay. Thus, the controller of the light effects is highly flexible. Light effects are pausable, stoppable and restartable at any time. The interface has two main parts. The player controllers and the extensional rule controllers. These are introduced in the followings.

5.4.1 Player controllers

In order to have a working life point visualization, logging of the gameplay activities is essential. This happens on the three player controller on the bottom of the screen (Figure 5.19). Each player controller corresponds to one player. During a player's turn, the four labelled buttons on the bottom (Beer, Arrow, Ggun and Shot) of the corresponding controller are supposed to be pushed according to the player's resolved dice. These buttons are controlling the corresponding light effects and refreshing the players' life point and arrow numbers.

All three controllers have a radio button that can be checked for the current player. This proved to be very useful for keeping track of the gameplay during the test sessions, where the facilitator had to also make notes in addition to controlling the light effects. As the shot is the most frequent player action, and has to be most in sync with player actions, the "Shot" buttons' are positioned in the most reachable position [56] and their hit area is at least two times the size of the other buttons.

On the top of each player controller, the number of life points (L:4) and arrows (A:4) are indicated. The minus (-) buttons next to them can be used to correct mistakes. The usage of these buttons does not trigger any light effects.

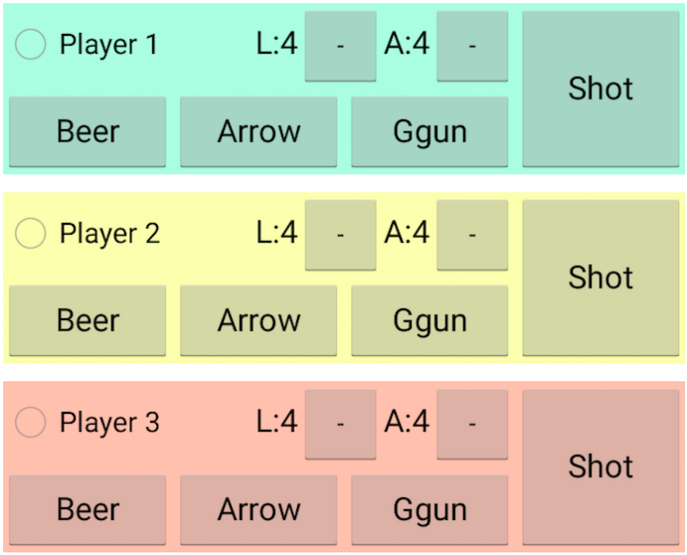

Figure 5.19: Logging of the gameplay and control of the interactive light effects happens on the three player controllers.

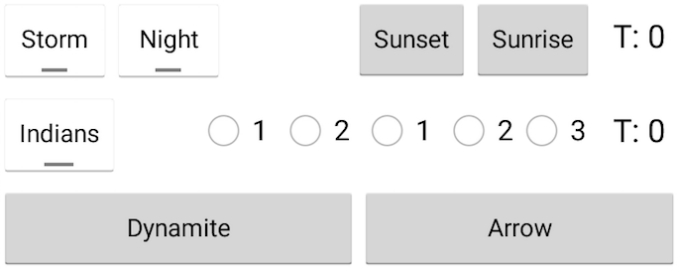

Figure 5.20: Extensional rule controllers trigger the light effects of the new rules.

5.4.2 Extensional rule controllers

Control of the extensional rules' light effects happens on the upper part of the interface (Figure 5.20). The Storm effect can be turned on and off with the help of the "Storm" toggle button. The preparatory phase of the night rule turns on by clicking the "Night" toggle button. The sunset effect is activated by clicking "Sunset" button. The night timer starts when all the lamps are off. The "Sunrise" button activates the sunrise effect and resets the timer and the "Night" toggle button.

The first phase of the Indian effects is activated by clicking the "Indians" toggle button. This also starts the Indian timer. The other phases are activated with the help of the radio buttons. The Indian timer restarts every time a new phase is activated. In case the players manage to defeat the Indians before the time is over,

the facilitator activates the dynamite effect with the help of the "Dynamite" button. Otherwise, the arrow effect is activated by the "Arrow" button. By pushing either of the two buttons, the Indian timer and the "Indians" toggle button gets reset.

6

Exploration with a light extended board game

The previous chapter discussed the design and development of a light extended board game prototype. After this step, the experimental prototype was used to evaluate the chosen role concepts that light could play in board games. The concepts were evaluated with 4 groups of 3 players playing the game on two separate sessions each. In this chapter first we explain the methodology we used for the evaluation and analysis of the results. After that we go into the details of the two types of test sessions and report their results.

6.1 Methodology

6.1.1 Evaluation

The methodology chosen for the test was similar to the one that was used to evaluate a digital table top game for senior citizens in Al Mahmud's work [2] (Section 2.3). Within subject test sessions were conducted for 4 groups of 3 players (12 participants in total). Each group participated two sessions where they played the game with different conditions. The first test sessions assessed the ambience support roles with the original game, while the second test sessions evaluated the gameplay element roles with the original game being extended by the extensional rules. In this way, players could get to know the base game on the first session and only learn the extensional rules on the second. This decision is based on an initial pilot test, where players had to learn all the rules on one session. When they finally understood the rules of the original game, they had to learn new rules again, which was really tiring and took away most of their motivation.

To assess the effect of the different light role concepts on the gameplay experience, a combination of quantitative and qualitative data was collected. For collecting qualitative data, we used Ijsselsteijn's Game Experience Questionnaire [30]. Since the subject pool of the tests was rather small, the results of the questionnaire should be handled with care. The goal of using this questionnaire was mainly to see how it can be used for such tests and to reveal indications that show difference between playing the games with the different conditions. To supplement the quantitative questionnaire results with qualitative data, a facilitator took notes of his observations on the gameplay. Furthermore, in the end of the sessions, semi structured discussions were ran by him, where participants reported their experiences. The same facilitator was also controlling light effects during the games.

6.1.2 Analysis

During the sessions qualitative data has been collected in the form of notes, about in game communication, player reactions and results. This has been done on a time-line with indicating corresponding user IDs for each quote and observation. In addition to that, quantitative data has been gathered with the help of the Game Experience Questionnaire. The analysis of these data is going to be

discussed in the following.

Qualitative data analysis

Qualitative data consist of words and observations, not numbers. As with all data, analysis and interpretation are required to bring order and understanding. This requires creativity, discipline and a systematic approach. [51] Most of these approaches comprise similar steps. Firstly it is important to get to know the data. This can be done by processing the data several times, which can mean reading notes or listening to tape recordings etc. Secondly it is important to focus the analysis according to the research questions. This can be done by categorizing the information by topics, time periods, events, participants etc. Finally, these categories can help to identify themes and patterns and create new categories that can help to give meaning and summarize the results.

While the analysis methods tend to be based on clustering and categorizing the information several times, the means of data manipulation needed for this process can be varying. One of the methods is affinity diagramming [29]. According to this method, notes and quotes are written on post it notes that are clustered manually. One of the main benefits of this method is the tangibility, that allows easy manipulation of the post it notes, which is essential when working in team.

The process can also be done digitally. This can happen in normal word processing applications, spreadsheets or in special qualitative data analysis tools that support coding the text, which can later be used for clustering. While these methods are perhaps faster in case of big amount of data - as preparation (printing, cutting) of tangible notes is not necessary -, to get a good overview of the data is more difficult, especially in a group setting.

As the data analysis process was preformed individually, we decided to use a quantitative data analysis tool for easier categorization of the data. The notes of the 8 test sessions were clustered into 109 groups. These classifications were based on aspects such as who were the notes about, when were they captured, at which game, with which condition, with or about what rule and light effect, mood of the participant, questions they answered. After finishing this process the clusters were analysed and new clusters were created in several iterations according to recognised patterns.

Quantitative data analysis

The collected quantitative data consists of the Game Experience Questionnaire results and game logs about results and success rate of different tasks. The Game Experience Questionnaire [30] consists of three modules that included several dimensions of user experience:

1. Core module
    (a) Competence
    (b) Sensory and imaginative immersion
    (c) Tension/Annoyance
    (d) Challenge
    (e) Negative affect
    (f) Positive affect
2. Social presence module
    (a) Psychological involvement - empathy
    (b) Psychological involvement - negative feelings
    (c) Behavioural involvement
3. Post-game module
    (a) Positive experience
    (b) Negative experience
    (c) Tiredness
    (d) Returning to reality

Each dimension consists of 3 to 6 questions that together gave a score for the corresponding dimension. As it was mentioned before, the subject pool of the tests was rather small. As a result, the quantitative data only provides indications. The scores of each participant, on each session have been summarized in a spreadsheet. This spreadsheet was also complemented by the log data from the notes later. Significance of the differences between the games with the different conditions were determined by the non-parametric Wilcoxon Signed-Rank Test. Furthermore, the

spreadsheet was also complemented with notes of player quotes and observations that refer to user experience. In this way it is possible to see if the notes are in sync with the questionnaire results.

6.2 Evaluation of the ambience support role concepts

On the first type of test sessions the ambience support light role concepts were evaluated. This included the static thematic ambience and 3 types of interactive light effects. Namely the life point visualization, shot and arrow effects.

6.2.1 Conditions

This session had two conditions (Figure 6.1). (1) One condition was playing the game without any light effects with the normal room lighting. (2) The other was playing the game with the light effects of the ambience support concepts, while the normal room lighting was turned off.

(a) Condition 1: Playig the game with the normal room lighting.

(b) Condition 2: Playing the game with special lighting.

Figure 6.1: The two conditions of the ambience support test.

The goal of the test with this two conditions was to reveal implications on the gameplay experience when the game is extended by a *static thematic ambience* and *interactive light effects*.

6.2.2 Structure

In the beginning of the sessions, participants were introduced to each other if they had not known each other already. After that, they got a short introduction of the project. In the next step, all participant received a copy of the game rules[1] and time to read them. The rules had also been sent out to the participants before the test, so for some of them they were already known. When everyone was ready, the participants started with a tutorial game. During this game, the facilitator who was also sitting at the same table, gave clarification for the rules if needed. After the tutorial game, the players played again the game two times with the two conditions. After each game, they were asked to fill out the Game Experience Questionnaire. In the end of the session, after they filled out the second questionnaire, a semi structured discussion took place, where the players reported their experiences. The order of playing the games with the different conditions was counterbalanced in order to eliminate the order effect. These orders are indicated in Table 6.1.

Session	Tutorial game	1st game	2nd game	Players
1.	No light	No light	Light	p11, p15, p18
2.	Light	No light	Light	p1, p2, p5
3.	No light	Light	No light	p13, p14, p17
4.	Light	Light	No light	p6, p7, p20

Table 6.1: Order of the conditions on the ambience support sessions.

6.3 Results of the ambience support sessions

The sessions went without any problems, most of the participants had a fun time playing the games. Even though it was recognised by several players that the game does not offer too much strategic depth by only playing it with 3 players [p1, p2, p5, p7, p11, p18], they still seemed to enjoy the games. Since the rules of the game are quite simple, understanding and learning them were not causing big problems. While in every group there was one player [p1, p7, p15, p17] who was more confused than the others, usually everyone played the game confidently after the tutorial game. The light effects were welcomed positively. There was a player who

[1]Rule sheet of the ambience support sessions can be found in the appendices.

even wanted to take pictures of the light settings. After the game, all participants reported that they found the light extension an interesting idea and it would be nice to have for other board games too. More details about the sessions are introduced in the followings.

6.3.1 Thematic ambience

The thematic ambience consisted of a constant light effect on all the 9 lamps. These were used to create a special thematic atmosphere in the room. During the discussions, 8 [p1, p2, p5, p6, p7, p13, p18, p20] out of 12 participants reported, that as a result of the special ambience, they were able to focus more on the game. While most of them used the word focused, others talked about being more into or immersed into the game.

"Lights made me focus more on the game, made it more immersive." [p18]

"Lights were cool! I was more into the game with them. The middle one (the desk lamp) was really useful, it made me focus!" [p13]

"You won't get distracted by other things around you. Now you can't see anything else, just the game." [p7]

"Effects were fun, ambience helped to focus. Lamp with tube really helps!" [p2]

Participants agreed, that while the darkness in the room and the lamps behind them created a cozy, isolated environment without any outside distraction, the desk lamp helped to focus fully on the gameplay by highlighting the gameplay area with its small beam. One of the participants [p1] reported excitedly that he was so much into the game with the lights, that he did not even take a look on his mobile phone during that game.

"Light helped me to focus on the game. I didn't even check my phone when playing with light. It's a big thing!" [p1]

While from this overview the importance of the ambience to support a theme is not obvious so far, one of the participants [p14] who is a frequent board game player said the following:

"Lights made a special visual atmosphere, just like board games create an atmosphere invisibly. Now this two were connected which was really nice!"

As it was discussed in Section 3.2.2, the pleasure of social interaction cited by

board game players, comes for the spontaneous involvement, that is basically the "invisible atmosphere" that [p14] refers to. This is created by the shared physical space and components. According to Goffman [26], this atmosphere provides a sense of security, increases relatedness and confirms the reality of the shared world of play. According to [p14] this atmosphere was extended with the help of the thematic lights, which may have caused the enhanced focus and immersion of players on the gameplay.

Besides all the benefits of this role, 2 players [p11, p18] (on the same session) reported visibility issues, such as little difficulties with reading the text on the character cards. Although, they could put it under the desk lamp and only had to read the cards once in the beginning of the game, this issue could be more serious for other games. One of the previously mentioned players [p18] also reported diffculties with recognising the beer symbol under the orange light, as it was also orange. Furthermore, one player [p15] reported that he sometimes felt nauseous because of the desk lamp.

6.3.2 Interactive effects

In addition to the static ambience, the game was also augmented by some interactive light effects on the players' individual lamps. These were the life point visualization, shot and arrow effects. Regarding the life point visualisation, most of the users [p6, p7, p11, p14, p15, p17, p18, p20] recognised that there were changes in the brightness of the heart lamps. However, they mostly recognised this when there were big changes in someone's life points or big life point differences between players. Some of these participants [p6, p7, p17, p20] were not even able to connect these brightness changes to the changes of life points. There were also players who did not recognise this feature at all. Moreover, there were one group of players [p1, p2, p5] suggesting the implementation of such a feature. One of the participants [p20] suggested a more obvious format by changing colours too. The most spectacular change of this feature was the heart beat effect, which started when players had less than 3 life points. This was recognised by all the participants and were even highlighted by a few of them [p1, p2, p5, p15] on the post-interview:

"I was impressed by the heartbeat effect!" [p15]

"Indians are the best and the heart beat!" [p2]

However this was not perfect either. Heartbeat effect is on, when the player has 1

or 2 life points, and the lack of feedback between these two levels caused some confusion for one of the participants [p15]. He thought he did not get his life points after gaining his life points from 1 to 2.

Some of the participants were surprised when they first saw the shot effect. Others were laughing on it or mimicked shot sounds [p6, p11, p14]. However, as the prototype was controlled by the facilitator, shot effects usually had quite big delay. As a result, it was obvious from the beginning for the players that it was controlled by the facilitator, thus it did not serve it's planed purpose. Which was an immediate feedback for a user action. In some cases players thought the facilitator missed to log their actions as a result of the delay. Participants [p1, p2, p5] reported that the delay was disturbing and an automatic shot effect would have been much more enjoyable. One indication which provides some basis for this opinion is the fact, that one of these players once recognised an Indian attack as a result of the light effects, which made him quite excited. In addition to this, two participants (on the same session) [p2, p5] perceived the yellow light effect as green.

According to some participants [p11, p20], these light effects open a new dimension for board games that is closer to computer games, which they found really interesting. Players may not paid a lot of attention to them during the game, but according to some of them, they added to the ambience and were indeed fun to have.

6.4 Evaluation of the gameplay element role concepts

On the second sessions, the gameplay element effects were evaluated. This included thematic indications, randomly triggered elements, thematic timers and challenges caused by special light conditions. These effect are part of the 3 extensional rules that we presented in Section 5.3.2. As a result, the players played the extended game on these sessions.

6.4.1 Conditions

This test had also two conditions. (1) The first condition was playing the extended game with all the light effects, except the life point visualization and shot effects.

More precisely, with the effects of the 3 extensional rules (randomly triggered elements, thematic indications, thematic timers and challenges caused by special light conditions) and the thematic ambience. (2) The second condition was to play the extended game without any light effects. Since several attributes of the new extensional rules rely on the light effects, solutions for using more or less the same rules without the effects had to be designed.

While with the first condition, the sand Storms and Indian attacks are triggered randomly, with the second condition to trigger these rules, an additional dice was used (Figure 6.2). Players rolled this dice in the beginning of their turn for possible sand storms and before finishing their turn, in case the number of arrows in the middle was less then five, to trigger possible Indian attacks. In this way, the random elements became elements triggered by players with the second condition. Furthermore, the Indian attack's recognition task - which is a challenge caused by special light condition - is eliminated in the game with the second condition.

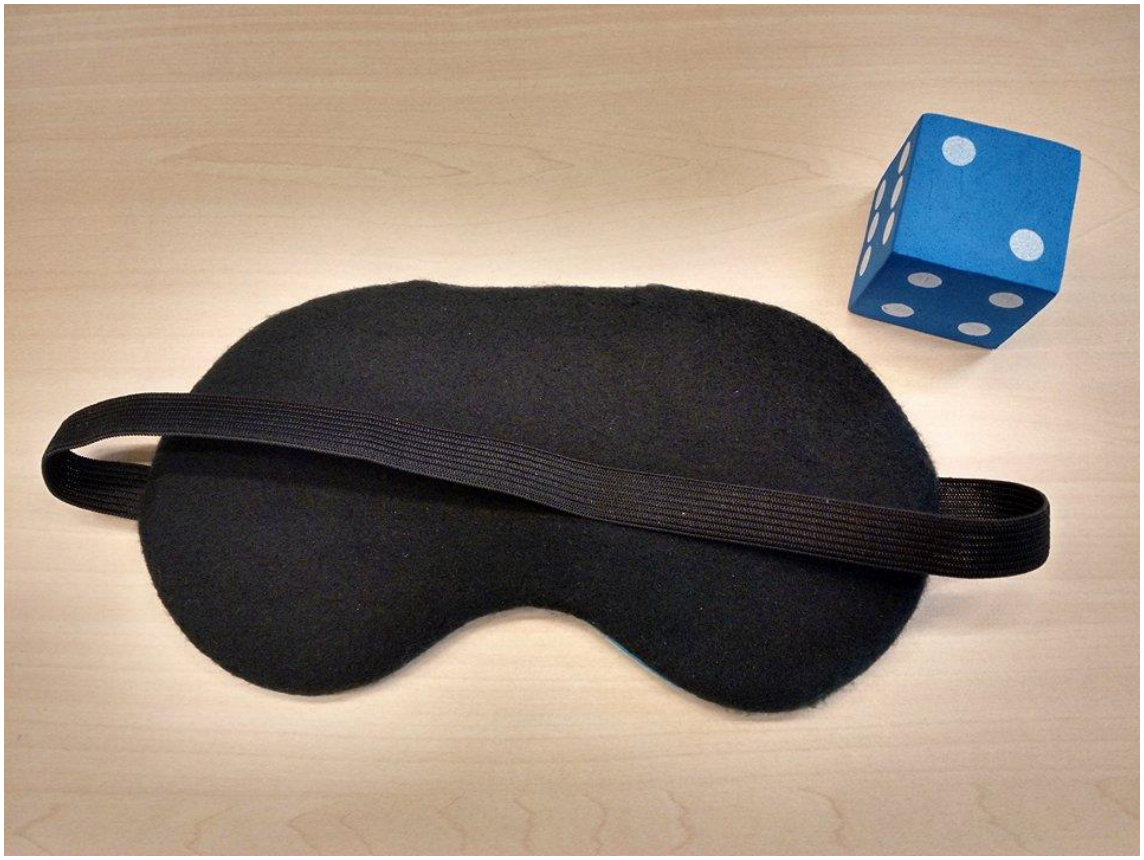

Figure 6.2: With the second condition, players wear blindfolds for the bank robbery and have to roll an additional dice to trigger sand storms and Indian attacks.

Both the Indian attack rule and the night rule incorporates an automatic thematic timer, which is replaced with a digital egg timer that needs to be controlled by the players in the game with the second condition.

The needed darkness for the bank robbery task in the night rule is created automatically by the lights with the first condition for all the three players. With the second condition, only two players can preform this task at the same time with wearing blindfolds (Figure 6.2). The third player controls the timer and informs the robbers if the time is over. In addition to that, while with the first condition, the guards are virtual, with the second condition the third player plays this role, and decides if a player still had dice in his hand when the time was over.

As it can be seen, with the second condition, random elements are triggered by users instead of happening randomly, thematic indications are eliminated, thematic timers are replaced with digital timers that need to be controlled by players and one of the challenges caused by light condition is eliminated and the other is replaced with the need that players have to recreate the special condition with the help of blindfolds.

The goal of this test with these two conditions was to reveal implications on the gameplay experience when the game is extended by a *static thematic ambience, randomly triggered elements, thematic indications, thematic timers* and *challenges caused by special light conditions.*

6.4.2 Structure

In the beginning of the test, participant were introduced to each other if they were not in the same group on their first sessions. On these sessions, two game were played with the previously introduced conditions. As the duration of the game was extended by the extensional rules[2], no separate tutorial game was played. Instead, the games were started right away and in every player turn, one new rule was introduced in practice by the facilitator. After all three new rules had been introduced, the players continued playing on their own. The players again filled out the same Game Experience Questionnaire after each of the games and had a semi structured discussion in the end. The order of playing the games with the different conditions was again counter balanced in order to eliminate the order

[2]Rule sheets of the gameplay element sessions can be found in the appendices.

effect. These orders are indicated in Table 6.2.

Session	1st game	2nd game	Players
1.	No light	Light	p5, p11, p20
2.	No light	Light	p6, p7, p21
3.	Light	No light	p13, p14, p17
4.	Light	No light	p1, p2, p18

Table 6.2: Order of the conditions on the gameplay element test sessions.

6.5 Results of the gameplay element sessions

On the second sessions, light played more role than pure ambience support. Now they had an effect on the gameplay as gameplay elements. These gameplay elements were mapped into to the game's context in the form of three new extensional rules: night, sand storm and Indian attack. These were introduced in Section 5.3.2.

Regarding the lack of the tutorial game, as all participants were already aware of the basic rules, getting used to the additional ones was relatively easy for them. There were only two participants who were noticeably confused at the beginning, while on the previous sessions almost all groups had one unsure participant. Participants were excited about the light effects, and all of them preferred the light extended game over the normal one.

"Can't we just go again with the lights?" - One of the participants [p13] said after the first game with light, before starting the second without light.

Reasons why participants preferred the light extended game over the other one, and evaluation of the new roles are discussed in the following.

6.5.1 Randomly triggered elements

During the discussions it turned out that all the participants recognised several benefits of the randomly triggered elements. First of all, they considered rolling an additional dice before and after their turns a tiresome activity, that breaks the original game's dynamic. They had to keep in mind when to roll this additional dice, why and what its effect is going to be. Players also often forgot about the night rule (on almost every session), and sometimes did not recognise that the

number of arrows in the middle indicated the need for rolling the additional dice for a possible Indian attack.

"The game is difficult with dice, with light everything is more straightforward." [p2]

"You can also not forget the rules with the help of lights." [p6]

While these problems would perhaps ease with more practice, participants still found playing the game much easier and fun with the lights, regardless of the order of the conditions. With the random elements they did not have to bother with keeping in mind the extensional rules and rolling the additional dice anymore, which made the gameplay more fluent. This is what the player quotes refer to as well in the following.

"Random elements are really nice with lights. With dice, the game just loses its dynamic." [p6]

In addition to that, most players talked about these random elements as an additional dimension in the game, that they had to pay attention to. This need for increased attention made them even more focused on the game, and caused uncertainty, excitement and surprises.

" - They can happen in any moment, which is more exciting! We also have to pay more attention, which gives another dimension to the game.

- Yes it is more fun! I guess later when you know the rules much better, the lights will still give much fun while the other game can get boring. It is really nice to be surprised.

- Yes, with the dice I know what's next, but not with the lights. It's really good!" [p14, p17]

"With light it's cozier. Quite fun and funny, makes me laugh! Requires more attention so it makes me more focused on the game." [p17]

"Game with lights makes you more involved." [p21]

6.5.2 Thematic indications

Participants generally liked the light effects. They were especially impressed by the effect of the night rule. Numerous players mentioned several times, how much they appreciated the slowly fading behaviour of the night effect.

"I really liked the night effect, and that it faded in slowly. It was really nice!" [p6]

"Nice one!!" [p14] at the start of the night effect.

"Light effects were nice!" [p7]

While the night effects were relatively easy to connect with the rule, other effects were more difficult. Some participant reported that in the beginning it was not too easy to connect the light effects to the corresponding rules, but later it got better.

"Light themes in the beginning just indicators, but then it gets easier to recognise them." [p11]

"At first you have to remember and connect all the effects to the rules, than you slowly recognise that they make sense. For example night is great." [14]

According to my observations, most often the sand storm effect was perceived mistakenly as an Indian attack. Usually only one player shouted excitedly that Indians were coming, and than other players corrected him. I see several explanations for these incidents. Firstly, these effects might not as easily connectible with their rules as a result of their implementation. Accordingly, these effects were more like indicators than thematic representations, that requires recall rather than recognition.

Secondly, these players who confused these two effects, were afraid of Indians because of the big number of arrows they had collected. Thus, they paid a lot of attention to recognise possible Indian attacks as soon as possible. As a result, they immediately shouted Indians whenever a flashing effect appeared. Although, the sand storm effect had a different colour and appeared on different lamps, it was indeed flashing too. And while it was flashing it still had the orange ambience, just like the Indian attack between two flashes. While these effects could obviously be improved, the Indian rule still achieved its goal, as players were continuously afraid of possible attacks.

Thirdly, sand storms happened right from the beginning of the game with similar flashing light effects, while players only experienced Indians later during the game. Before that, they had only seen the effect once in the tutorial part, which was obviously not enough to be able to recall all the three new rule - light effect connections. This assumption can also be confirmed by the fact, that players tended to recognise Indian attacks already in their first phases when they really came.

Despite of the initial confusions, players were able to connect the effects with the corresponding rules, and it was also easier for them to understand the rules with the lights during the tutorial games.

6.5.3 Challenges caused by special light conditions

There were two challenges created by special light condition. Firstly, the night task turned out to be a really difficult one. Only 58% of the participants were able to fulfill this task at least once. Despite of this, players reported that they enjoyed doing skill tasks mixed with other board game elements. They found this idea rather interesting. However, some players thought having this rule without light, with the eye blanks is too much burden.

"Nice rule with lights, but too much burden without" [p13]

"It's interesting to add these kind of tasks during board games" [p18]

"Good idea to add tasks that require skills. Everyone can do these tasks at the same time which is nice. (everyone is involved)" [p5]

There was one player who thought having skill tasks in board games is a mistake, as it is easier to practice them, which can cause big differences amongst players. Which is a valid point, that should be considered. While this experimental game had only one skill task which was always the same, in a real product more versatile tasks should be designed that would make practising more difficult. This was recognised by another player who thought, having this task for now was interesting, but he would expect more exciting tasks later.

"Liked to use skills, it was fun, but in a product I would expect more exciting tasks. It was nice for a few games, though." [p7]

Regarding the second challenge created by this role, from the discussions it turned out, that players found it a fun new challenge to be prepared and recognise when the Indians were coming. Without the lights, they had to roll a dice to trigger an Indian attack, so they were always aware about what was about to come. The randomness with the light on the other hand, created uncertainty and excitement.

"With the dice I know what's next, but not with the lights. It's really good!" [p14]

"It's really nice to be surprised." [p17]

According to the discussions, for some of the participants it was easy, for some it

was difficult to recognise the Indians. There were also players who reported that they recognised the effect soon but did not notify others about it because of tactical reasons. Nevertheless, Indians were recognised every time in the 1st or 2nd phase with one exception. This was on an early morning test, where only one player had to fight. While other players recognised the effect and told him to fight, he was too tired to understand or care about what he had to do.

6.5.4 Thematic timers

There were two thematic timers in the game. One in the Indian rule and another in the night rule. Concerning the Indian rule's timer, players reported that they were so focused on the task of fighting the Indians, that they did not recognise any changes of the lights after starting to fight the Indians. Thus, showing the passage of time on the ambience lamps during a task that needs concentration were unsuccessful. Nevertheless, players always recognised when they were defeated by the Indians, as it was visualised on the individual lamps in front of them. They also recognised the dynamite effect on the ambience lamps behind them, when they defeated the Indians. The reasons for that can be, that it was a feedback of a successfully completed task, so it happened right after they finished the task. However, it was also a quite intense effect, that changed the whole ambience to red.

Comments concerning the night rule's timer, are only related to the rule itself. According to the rules, by the beginning of sunrise, players should not have any dice in their hands, otherwise they get shot buy the guards and lose life points. However, players were only manipulating the dice on the table, so there were no chances that anyone could have got shot. This was recognised and disliked by some of the players. They expected some kind of punishment in case they cannot succeed in the task which would have caused fear.

"I liked it a lot but it would be more exciting to add some fear. Now you can't really lose anything with it." [p1]

"How can I lose life if my dice are always on the table? It's stupid!" [p11]

Despite of this, according to my observations, the feedbacks of this timer - starting-sunset and stopping-sunrise - worked very well. More precisely, players could prepare for the task, they knew what was happening and recognised when the time was over. There was no need to indicate the passage of time, which caused basically one of the challenges in the night task.

6.5.5 Questionnaire results

While questionnaire results did not show any significant difference between the two games on the ambience support sessions, according to the gameplay element sessions' questionnaire results, sensory immersion of the players, that is the sensation of being surrounded by a completely other reality, that takes over all of our attention [24], and flow that is a highly intensive state, where one is fully absorbed within the activity and gains powerful gratification [24] increased with high statistical significance ($p \leq 0.01$) (Figure 6.4, Figure 6.3). While the results acquired from the questionnaires are not representative with the low number of samples, they are still in line with what the participants said about the games. Which is, gameplay with the lights got more fluent and exciting. Players focused more on the game and became more drawn into it. On the following charts, all the participants of the gameplay element sessions are indicated.

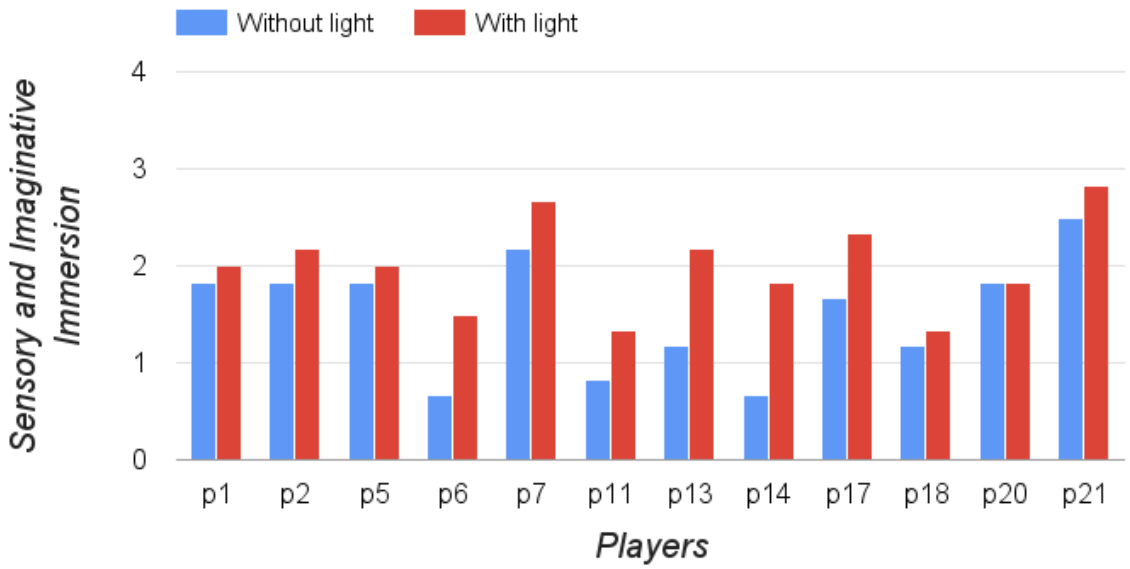

Figure 6.3: Sensory immersion of the players on the gameplay element sessions increased with high statistical significance ($p \leq 0.01$) when playing the light extended game.

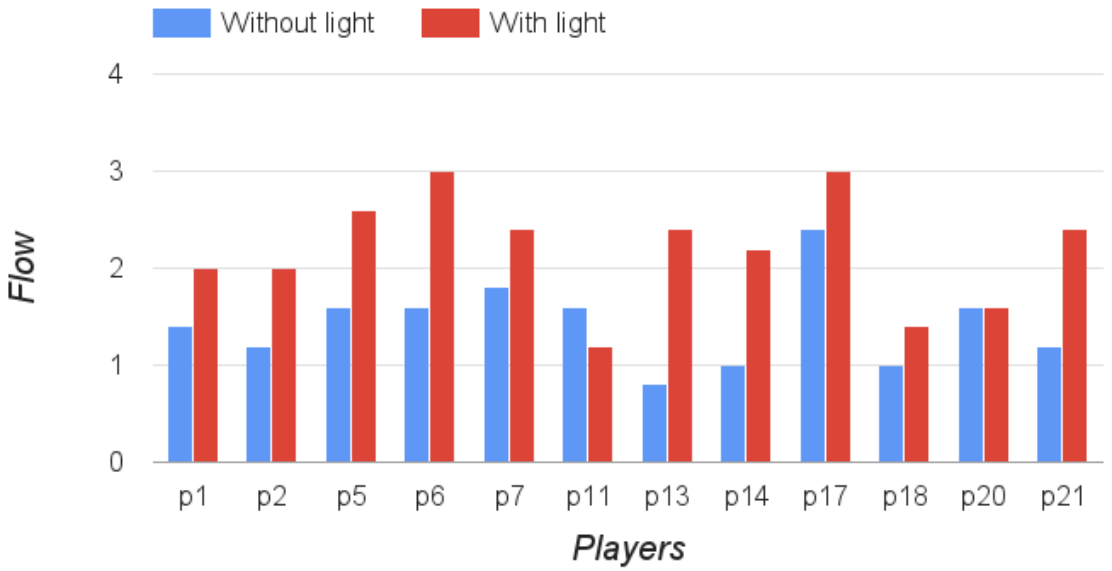

Figure 6.4: Flow of the players on the gameplay element sessions increased with high statistical significance ($p \leq 0.01$) when playing the light extended game.

Furthermore, the positive affect component increased by $p \leq 0.05$ significance (Figure 6.5) which indicates elevated enjoyment of the players after finishing the light extended game compared to the normal one.

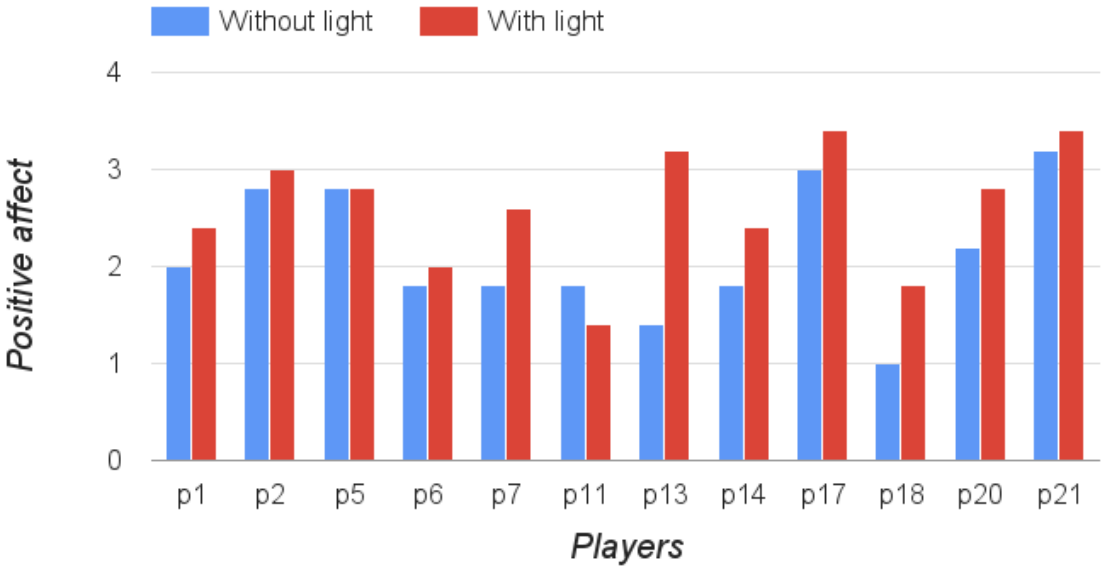

Figure 6.5: The positive affect component increased by $p \leq 0.05$ significance, which indicates elevated enjoyment.

7

Discussion

While the previous chapter gave an insight in the test sessions and their results, in this chapter we discuss their implications.

Enhanced immersion and focus

One of the most interesting findings of the first test sessions, was that a thematic environment created by static light effects, can support the otherwise invisible atmosphere that a board game creates. The resulting atmosphere helps players immerse more into the game and forget about outside distractions.

On the second type of sessions, this static ambience was extended by different thematic light effects, such as thematic timers, challenges caused by special light conditions and randomly triggered elements indicated by thematic light effects. According to the findings, players' focus is enhanced even more when random elements of board games are automatically triggered in random times and indicated by thematic light effects. In this case, players have to pay more attention to the created environment, as recognising and interpreting the effects is an important part of the game. In a sense, it gives an additional dimension to the game.

Excitement and uncertainty

This new dimension also creates excitement and uncertainty during the game, as the random elements are not connected with any kind of player action that could be used to predict what is going to happen. This excitement can be enhanced even more, if they are used as an additional challenge (challenge created by special light condition). An example for that is the Indian rule's recognition challenge, where short flashes need to be recognised as soon as possible in order to successfully complete a task.

Further exploration of recognition challenge

While players reported that they enjoyed the Indian recognition challenge, it proved to be relatively easy. As a result, adjusting and experimenting more with the corresponding light effects would be interesting.

More fluent gameplay

According to the discussions with the participants, the randomly triggered and thematically indicated elements do not just cause uncertainty and make players focus more on the game, but also make the gameplay more fluent, together with

the thematic timers. The reason for that, is by using these elements, players do not have to take care anymore about triggering the random elements manually, or turning on and paying attention to timers. They can just play the game with manipulating the essential game tools, without breaking the game's dynamic, and as a result, experiencing elevated flow.

Further exploration of randomly triggered elements

Although, most of the participants agreed that the gameplay of the light extended game is more fluent, it is worth to mention that it is might caused by the design of the new rules. Each of the roles evaluated on the second sessions, were part of three newly designed, additional rules to the original game. As a result, testing these elements with board games, that originally have interesting random elements would be beneficial for further exploring these roles. This could be done, by designing light effects for these original elements, and comparing the gameplay with the conditions of randomly triggering the elements and triggering them by dice but still indicating them by light. Unfortunately these games are much more complex, have long learning curve and really long gameplay. As a result, they did not fit into the scope of this study.

Scheduled and more complicated tasks

Nevertheless, instead of generally stating, that randomly triggered thematically indicated elements make board games more fluent, it can be said, that more complicated or scheduled tasks can be created with them easily. While in this game, players had to roll a dice both before and after their turn, and remember a rule that happened between two player turns in every two rounds, this kind of complicatedness is not too frequent in board games. However, by using randomly triggered thematic light effects to indicate random elements, the game got much easier than without the lights.

Accordingly, we propose that by automating the right activities in a board game - in this case trigger of random elements and timers - and keeping adequate amount of tangibly manageable routine activities, player effort can be reduced without decreasing enjoyment. In this case, with the help of thematic light effects, enjoyment was even increased. This may serve as a confirmation for Wallace et al.'s [53] interpretation that in their case the reduced player enjoyment was caused

by adapting their game to a digital platform, as a result taking away all the tangible elements.

Further exploration of thematic timers

Thematic timers were preferred over the egg timers. Firstly, players did not have to bother with starting them, secondly they did not have to pay a lot of attention to them either, as start and stop feedback were considered to be obvious and well embedded in the thematic effects.

The Indian timer was supposed to indicate the passage of time and raise player excitement. This was done by more and more intensive light effects on the ambience lamps around the players. However, players were so focused on the task, that no one recognised these changes at all. While, players sometimes became quite excited during the task, it is also not obvious if the flashing light had any part in this excitement. As a result, this role could be also further explored by using light effects that the players actually recognise, and determine if they play any part in making players more exited during the tasks.

Easing the rule learning problem

One of the biggest problems of casual players with board games, is the boring task of learning their rules and even worse, interpreting them from the rule book [55]. This was discussed in Section 3.3.2. There are a few indications that implies this problem can be eased by light. The hypothesis is the following: Thematic indications help players memorize rules faster, which supposed to get even better by implementing more authentic light effects. Consequently, randomly triggered elements also help in learning the rules (fast start of the game) as players do not have to keep additional activities in mind, just connect the rules with the thematic effects that come automatically.

An even better solution for the problem could be a tutorial presented by a mobile application. Running a mobile application for playing such a game would be essential anyway. (Except, if the the logic is embedded somehow in the physical game.) According to my observations, learning the rules is much easier by seeing the light effects and getting an explanation of the corresponding rules, than without the lights or from a rulebook. This explanation could be done by the

application, in a way, that each light effect is shown in connection with the corresponding rules/activities visualised by the interface.

Importance of feedback

The test also revealed the importance of adequate feedback for player actions. Although, this guideline has been known before, the design still included some problems related to feedback. Firstly, there should not be delay. The delayed shot effect was rather disturbing for players. However, an unexpected arrow effect showed that having these interactive effects can be really beneficial without delay (Section 6.3.2).

Secondly, consistency of feedback is important too. If there is feedback for losing and gaining life points, they should be there in every case. The unexpected absence of feedback between having 1 or 2 life points made one of the players think, that something went wrong.

Interactive effects

As a result of the shot effect's delay problem, it is difficult to determine how much it adds to the game experience. In the future, testing these kinds of effects should be done by a more complex prototype, that can trigger the effects in sync with user actions automatically.

The benefits of having life point visualisation is also hard to assess. Although the red individual lamps obviously added to the overall ambience, as a functionality, they did not worked perfectly. Differences between the brightness levels were too low to recognise. Unfortunately these were the maximum possible levels in a way, to not cause disturbing glare when having maximum amount of life points. Also one's life point level can only be determined by comparing his lamp's brightness to a reference. As a result, only the differences in the amount of life points between players were possible to recognise. However, not accurately either, because of the too small brightness differences. Better information visualisation is needed, that does not go on the expense of the thematic ambience.

All in all, while some participants referred to these effects as a fun to have direction towards computer games, only two participants missed them from the second test sessions, where they were not used. Despite of this, these usability

problems made us recognise the importance of these feedbacks in a fully functional game. Players require some kind of feedback that indicates that the system recorded their actions.

Equilibrium between physical and digital elements

One interesting aspect would be to try the game with a more obvious life point visualisation form, without the life coins. During one of the games, players were confused several times when they had to deal with life coins. They made mistakes and others corrected them [p5, p2, p1]. According to one of the learnings explained before, by limiting the tasks users need to keep in mind, the dynamic of the game can be maintained, thus enhancing the flow. Perhaps, by only using automatic scoring the flow could be enhanced even further. By trying this aspect, the equilibrium between board games and computer games could be explored further. In other words, how much physical interaction is needed in a board game to still maintain the main benefits of classical board games (sociality, players in control, nice tangible parts for intuitive interaction), but at the same time, provide high level of flow, by providing easy gameplay without the need to remember how to use the numerous accessories.

Having challenges that require skills in board games

Including challenges that require skills into board games proved to be an exciting concept. Nevertheless, better adjustment is needed to determine the adequate difficulty for the tasks. In this case, one of the tasks was too easy, while the other was rather difficult. As it was already mentioned, the Indian recognition task had several benefits (more focus, surprise). On the other hand, the night task is obviously an experimental task. It is interesting if not tried a lot of times. Otherwise players get practised, which can cause unjust differences between them. As a result, more varied tasks are needed. All in all, light can be used to create interesting tasks without a question, and the welcome of mixing skills amongst strategy and luck was also positive.

8

Conclusion

In the previous two chapters the evaluation of the different role concepts were introduced and discussed. This chapter summarizes the key findings of this project and concludes the thesis in listing the possible next steps of the research.

8.1 Key findings

The goal of the thesis work was to explore how light can enhance the gameplay of modern board games. To be able to answer this question firstly we framed the design space of light extended board games that consists of 4 areas that offers significant potential in further research (Section 4.2). Secondly, after focusing the design space to the area of augmenting existing board games, we propose 3 categories of roles, that light could play in board games, that also formed our sub-questions. These are ambience support gameplay elements and game tools. In this thesis we introduced and evaluated 2 ambience support roles and 4 gameplay element roles. While there were several game tool roles discovered during the ideation sessions, further exploration of this group is needed in the future, as it did not fit into the scope of this project.

Regarding the ambience support roles, evaluation of the static thematic ambience obviously showed, that it can create a special visual ambience that is connected to the invisible atmosphere of board games. As a result of the extended atmosphere, players experience an enhanced focus and are being more drown into the game. On the other hand, the second ambience support role, namely the interactive effects unfortunately include some usability issues that prevented their proper evaluation. While several participants enjoyed them and reported that these effects create a new dimension that is closer to computer games, further exploration is still needed to determine their effect on the gameplay experience.

Concerning the gameplay element roles, 3 new extensional rules were designed for the original game, in order to be able to assess 3 randomly triggered elements that were indicated thematically, 2 thematic timers and 2 challenges caused by special light conditions. The rules were designed to function both with and without the light effects. In case of this game, the evaluation showed that firstly, good thematic indications not just enhance sensory immersion, but help players connect light effects with corresponding rules. Secondly, randomly triggered elements make the game more exciting by causing surprise and uncertainty. As a result, they create a new dimension in the game, that players have to pay attention to and thus focus more on the game. Thirdly, with the help of randomly triggered elements and automatic thematic timers, players do not have to bother with manually triggering random elements and control, pay attention to timers. Instead, they can focus on the essential game tools, which make the gameplay more fluent and as a result, enhance players' flow. The evaluation also showed that

light can be used to create challenges with the help of special light conditions.

While the static thematic ambience that were evaluated with the original game might be generalised more to other thematic board games too, gameplay element roles need more validation. Nevertheless, the test showed that light can be used to enhance the gameplay of a modern board game in several ways.

8.2 Future work

Throughout the previous chapter a few future directions for exploring light extended board games further have been pointed out. These were mainly about validating and exploring the current roles further, either by trying them with other games or adjusting the current rules or effects. These are briefly listed in the following.

Amongst the interactive effects there were two significant usability issues that prevented their proper evaluation. These were the delay of the shot effect, and the vague life point visualisation. In the future, a more complex prototype is needed to provide the shot effects in sync with user actions. Furthermore, better information visualisation is needed, that does not go on the expense of the thematic ambience.

Further exploration of the randomly triggered elements is also necessary. Firstly, it would be beneficial to test them with a game that originally has interesting random elements. Furthermore, it would be worth to evaluate them separately from the thematic indications. It could be done with the help of the following two conditions: 1, Randomly triggered elements visualised by thematic indications. 2, Manually triggered elements, and when players trigger them, they are also visualised by thematic indications. In this way the evaluation will be really focused on only the randomly triggered elements.

The Indian recognition challenge which is a challenge caused by special light conditions turned out to be an easy task. As a result, it would be interesting to adjust on the light effects and see how players react if the effects become more hardly recognisable.

The Indian timer rather than only being a timer, was also supposed to indicate the passage of time and raise player excitement. However, players were so focused on the task of fighting the Indians, that they did not recognise any changes in the light effects. It is also not obvious if the flashing light effects had any part in

making the players more excited or it was only the result of their activity. As a result, further exploration should be done about how the passage of time can be indicated for players during tasks, or if it is needed at all. Moreover, to determine if flashing light effects during a task make the task more exciting.

It is also worth to mention that the area of light extended board games offer numerous potentials. There are much roles to explore beyond the ones that were presented in this thesis. While ambience support and gameplay elements can be a good addition to already existing board games, light solutions as game tools could create totally new types of games.

Bibliography

[1] Gregory D Abowd and Elizabeth D Mynatt. "Designing for the human experience in smart environments". In: *Smart environments: technologies, protocols, and applications* (2005), pp. 151–174.

[2] Abdullah Al Mahmud et al. "Designing and evaluating the tabletop game experience for senior citizens". In: *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*. ACM. 2008, pp. 403–406.

[3] Dzmitry Aliakseyeu et al. "Beyond the switch: explicit and implicit interaction with light". In: *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*. ACM. 2014, pp. 785–788.

[4] Dzmitry Aliakseyeu et al. "Designing interactive lighting". In: *Proceedings of the Designing Interactive Systems Conference*. ACM. 2012, pp. 801–802.

[5] Dzmitry Aliakseyeu et al. "Interactive city lighting". In: *CHI'13 Extended Abstracts on Human Factors in Computing Systems*. ACM. 2013, pp. 3191–3194.

[6] Dzmitry Aliakseyeu et al. "The role of ambient intelligence in future lighting systems". In: *Ambient Intelligence*. Springer, 2011, pp. 362–363.

[7] Dzmitry Aliakseyeu et al. "User interaction techniques for future lighting systems". In: *Human-Computer Interaction–INTERACT 2011*. Springer, 2011, pp. 744–745.

[8] *Another Strong Season for Game Sales*. ICv2. Oct. 2014. URL: `http://icv2.com` (visited on 06/2015).

[9] Jonathan Barbara. "Measuring User Experience in Board Games". In: *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS)* 6.1 (2014), pp. 64–79.

[10] Steve Benford, Carsten Magerkurth, and Peter Ljungstrand. "Bridging the physical and digital in pervasive gaming". In: *Communications of the ACM* 48.3 (2005), pp. 54–57.

[11] Nick Bentley. *Board Game Publishers are Doing it Wrong*. Nick Bentley Games. Sept. 2013. URL: https://nickbentleygames.wordpress.com/ (visited on 07/2015).

[12] *Board game*. Wikipedia. URL: https://en.wikipedia.org (visited on 07/2015).

[13] *BoardGameGeek*. Wikipedia. URL: https://en.wikipedia.org (visited on 06/2015).

[14] John Bowlby. *Attachment and loss*. Vol. 3. Basic books, 1980.

[15] Board Game Breakfast. *Episode 51 - Playing the game the "right" way*. [YouTube]. 2014.

[16] Jeanne H Brockmyer et al. "The development of the Game Engagement Questionnaire: A measure of engagement in video game-playing". In: *Journal of Experimental Social Psychology* 45.4 (2009), pp. 624–634.

[17] D Bunten. *On-line multi-player games*. 1996.

[18] Cody Carlson. *We are living in a board game renaissance*. Deseret News. Aug. 2013. URL: http://www.deseretnews.com/ (visited on 06/2015).

[19] Matthew Chalmers, Ian MacColl, and Marek Bell. "Seamful design: Showing the seams in wearable computing". In: (2003).

[20] G Costkyan. "I have no words & I must design: toward a critical vocabulary for games". In: *Proceedings of the computer games and digital cultures conference, Finland*. 2002.

[21] Mihaly Csikszentmihalyi. *Beyond boredom and anxiety*. Jossey-Bass, 2000.

[22] Heather Desurvire, Martin Caplan, and Jozsef A Toth. "Using heuristics to evaluate the playability of games". In: *CHI'04 extended abstracts on Human factors in computing systems*. ACM. 2004, pp. 1509–1512.

[23] Owen Duffy. *Board games' golden age: sociable, brilliant and driven by the internet*. The Guardian. Nov. 2014. URL: http://www.theguardian.com (visited on 06/2015).

[24] Laura Ermi and Frans Mäyrä. "Fundamental components of the gameplay experience: Analysing immersion". In: *Worlds in play: International perspectives on digital games research* 37 (2005).

[25] Ethan Gilsdorf. *Board games are back, and Boston's a player*. The Boston Globe. Nov. 2014. URL: http://www.bostonglobe.com/ (visited on 06/2015).

[26] Erving Goffman. "Fun in games". In: *Encounters* (1961), pp. 17–81.

[27] Talks at Google. *Talks at Google in conversation with "Ticket to Ride" co-creator Eric Hautemont*. [YouTube]. 2013.

[28] Wilko Heuten and Susanne Boll. "Illumination of calendar events in the household of older persons". In: *Constructing Ambient Intelligence*. Springer, 2012, pp. 35–40.

[29] Karen Holtzblatt and Hugh Beyer. "Making customer-centered design work for teams". In: *Communications of the ACM* 36.10 (1993), pp. 92–103.

[30] WA IJsselsteijn, YAW De Kort, and K Poels. "The Game Experience Questionnaire: Development of a self-report measure to assess the psychological impact of digital games. Manuscript in Preparation". In: (2013).

[31] Wijnand IJsselsteijn et al. "Characterising and measuring user experiences in digital games". In: *International conference on advances in computer entertainment technology*. Vol. 2. 2007, p. 27.

[32] Wijnand IJsselsteijn et al. "Measuring the experience of digital game enjoyment". In: *Proceedings of Measuring Behavior*. Maastricht Netherlands. 2008, pp. 88–89.

[33] Aki Järvinen. *Games without frontiers: Theories and methods for game studies and design*. Tampere University Press, 2008.

[34] Charlene Jennett et al. "Measuring and defining the experience of immersion in games". In: *International journal of human-computer studies* 66.9 (2008), pp. 641–661.

[35] John F Kelley. "An iterative design methodology for user-friendly natural language office information applications". In: *ACM Transactions on Information Systems (TOIS)* 2.1 (1984), pp. 26–41.

[36] Philips Lighting. "The Future of Light". In: *New York: psfk* (2013).

[37] Carsten Magerkurth. "Hybrid gaming environments: keeping the human in the loop within the Internet of things". In: *Universal Access in the Information Society* 11.3 (2012), pp. 273–283.

[38] Carsten Magerkurth, Timo Engelke, and Maral Memisoglu. "Augmenting the virtual domain with physical and social elements: towards a paradigm shift in computer entertainment technology". In: *Computers in Entertainment (CIE)* 2.4 (2004), pp. 12–12.

[39] Carsten Magerkurth et al. "Pervasive games: bringing computer entertainment back to the real world". In: *Computers in Entertainment (CIE)* 3.3 (2005), pp. 4–4.

[40] Todd Martens. *Board games are growing in popularity again*. Los Angeles Times. Nov. 2012. URL: http://articles.latimes.com/ (visited on 06/2015).

[41] Taro Narahara. "Exploring board game design using digital technologies". In: *ACM SIGGRAPH 2014 Studio*. ACM. 2014, p. 10.

[42] S. Nicholson. "Peeking behind the locked door: A survey of escape room facilities". White Paper available at http://scottnicholson.com/pubs/erfacwhite.pdf. 2015.

[43] Jakob Nielsen. "10 usability heuristics for user interface design". In: *Fremont: Nielsen Norman Group.[Consult. 20 maio 2014]. Disponivel na Internet* (1995).

[44] *Not twilight, but sunrise: Table-top games are booming in the video-game age*. The Economist. Oct. 2015. URL: http://www.economist.com (visited on 10/2015).

[45] Peter A Piccione. *In search of the meaning of Senet*. Archaeological Institute of America, 1980.

[46] Gil Press. *Internet of things by the numbers: Market estimates and forecasts*. Forbes. Aug. 2014. URL: http://www.forbes.com/ (visited on 06/2015).

[47] Allison Sall and Rebecca E Grinter. "Let's get physical! in, out and around the gaming circle of physical gaming at home". In: *Computer Supported Cooperative Work (CSCW)* 16.1-2 (2007), pp. 199–229.

[48] Hana Schank. *How Board Games Conquered Cafes*. The Atlantic. Nov. 2014. URL: http://www.theatlantic.com (visited on 06/2015).

[49] Jaakko Stenros, Annika Waern, and Markus Montola. "Studying the elusive experience in pervasive games". In: *Simulation & Gaming* (2011), p. 1046878111422532.

[50] Norbert Streitz et al. "From information design to experience design: smart artefacts and the disappearing computer". In: *interactions* 12.4 (2005), pp. 21–25.

[51] Ellen Taylor-Powell and Marcus Renner. *Analyzing qualitative data*. 2003.

[52] Ingrid Vogels. "Atmosphere metrics". In: *Probing experience*. Springer, 2008, pp. 25–41.

[53] James R Wallace et al. "Exploring automation in digital tabletop board game". In: *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work Companion*. ACM. 2012, pp. 231–234.

[54] Markus Waltl, Christian Timmerer, and Hermann Hellwagner. "Increasing the user experience of multimedia presentations with sensory effects". In: *Image Analysis for Multimedia Interactive Services (WIAMIS), 2010 11th International Workshop on*. IEEE. 2010, pp. 1–4.

[55] Stewart Woods. *Eurogames: The design, culture and play of modern European board games*. McFarland, 2012.

[56] Luke Wroblewski. *Designing for Large Screen Smartphones*. Oct. 2014. URL: `http://www.lukew.com/` (visited on 07/2015).

[57] José Pablo Zagal, Miguel Nussbaum, and Ricardo Rosas. "A model to support the design of multiplayer games". In: *Presence: Teleoperators and Virtual Environments* 9.5 (2000), pp. 448–462.

Appendices

1. **Original rules of Bang! the dice game for 3 players**
2. **Base rules of the extended game**
3. **Extensional rules of the game with light**
4. **Extensional rules of the game without light**

1. Original rules of Bang! the dice game for 3 players

Preparation

At the start of the game, players each take a role card, that can be: the Deputy, Renegade, or Outlaw. Each player also receives a character card which grants him a special power in the game.

Goal Of The Game

The player who first reaches his goal (makes his target lose his last life point) is the winner. If another player dealt the final hit, then the goal for both survivors is to be the last man standing.

- The **Deputy** needs to kill the ***Renegade***
- The **Renegade** needs to kill the ***Outlaw***
- The **Outlaw** needs to kill the ***Deputy***

The Game

On a turn, you can roll the five dice. You may then choose to keep the dice or re-roll some or all of them up to two times. If you roll a third time, you may also re-roll any dice you didn't choose to re-roll on your second roll. You must accept the third roll.

When you are satisfied with your dice roll (or you're out of re-rolls), resolve the dice results. When dice resolved on other players, they should be put in front of them. You must apply all the dice results in the following order. You cannot pass on a rolled dice: you must use them all!

Arrow: *You must resolve this dice **immediately** when rolled, not at the end of his turn.* Take one arrow token (one per arrow rolled). You may roll this dice again if you have re-rolls left. If you take the last arrow, the Indians attack and each player loses one life point for each arrow in front of him. After the attack, all players discard their arrows, and you resume your turn.

Dynamite: *This dice **cannot** be re-rolled!* If you roll three or more Dynamites, your turn ends immediately and you lose one life point. But, all your other dice results are still resolved as normal.


Shot: Choose a player you want to shoot. The player loses one life point.

Beer: Choose any player that gains one life point.

Gatling: If you roll three or more Gatlings you activate the Gatling gun, and each of the other players loses one life point. Also, you discard all of your arrows.

2. Base rules of the extended game

Preparation

At the start of the game, players each take a role card, that can be: the Deputy, Renegade, or Outlaw. Each player also receives a character card which grants him a special power in the game.

Goal Of The Game

The player who first reaches his goal (makes his target lose his last life point) is the winner. If another player dealt the final hit, then the goal for both survivors is to be the last man standing.

- The **Deputy** needs to kill the ***Renegade***
- The **Renegade** needs to kill the ***Outlaw***
- The **Outlaw** needs to kill the ***Deputy***

The Game

On a turn, you can roll the five dice. You may then choose to keep the dice or re-roll some or all of them up to two times. If you roll a third time, you may also re-roll any dice you didn't choose to re-roll on your second roll. You must accept the third roll.

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Arrow: *You must resolve this dice **immediately** when rolled, not at the end of his turn.* Take one arrow token (one per arrow rolled). You may roll this dice again if you have re-rolls left. ~~If you take the last arrow, the Indians attack and each player loses one life point for each arrow in front of him. After the attack, all players discard their arrows, and you resume your turn.~~

Dynamite: *This dice **cannot** be re-rolled!* If you roll three or more Dynamites, your turn ends immediately and you lose one life point. But, all your other dice results are still resolved as normal.


Shot: Choose a player you want to shoot. The player loses one life point.

Beer: Choose any player that gains one life point.

Gatling: If you roll three or more Gatlings you activate the Gatling gun, and each of the other players loses one life point. Also, you discard all of your arrows.

3. Extensional rules of the extended game with light

The light of the ***desk lamp*** represents the state of game. As long as it shines in the same yellow color, normal turns can continue. Changes in its light always indicate changes in the game state that are the followings:

Night

The sun sets in every <2> rounds and ***all*** the players have a chance to rob the bank. They can earn <2> life points in case successfully finding the combination of the safe in the dark, before the guard (virtual) catches them.

1. Preparation phase: The preparation phase of the night is indicated by blue color.

   After the players finish the last ongoing round, they can start to prepare for the night. When the players are ready, and each of them is holding a closed bag of 5 dice, the sunset phase starts.

2. Sunset phase: After all the lights go out, the players can open the bags, spill out the dices on the table. Their task is to organize the dice on the table with different symbols facing up on all of them. They can do this buy using their tapping skills to distinguish between the different symbols.

3. Sunrise phase: By the time the first lamps turn back, all dice should be on the table otherwise the players get caught by the guard.

   a. The players who still had any dice in their hands at that moment get shot by the guard. So they lose one life point.

   b. The players whose dice were already on the table with the correct combination gain <2> life points.

   c. The players whose dice were already on the table, but with not the correct combination do not get or lose any life points.

After sunrise the normal rounds can be continued.

Sand Storm

Sand storm can happen randomly during any player's turn, any time. It is indicated by blinking lights. In case, it happens, the two other players turn their role cards up-side-down and mix them. As a result, the aiming player cannot be sure who he is shooting.

Indian attack

Indian attacks can happen any time when the number of arrows in the middle is <4> or less.

Indians can be fought by having 5 dynamites rolled. One player can only roll one die at a time. In case the players cannot roll 5 dynamites in time, they lose against the indians and each of

them loses as many life points as many arrows they have in front of them at the moment. Otherwise everyone can put back <2> arrows.

An indian attack has 5 phases:

1. 1st Observation phase: Indians start to observe the players. Short purple blinks appear on the ambience lights around the players. If the players recognise these and any of them decides to start fighting back the indians, the current round stops and the players start the fight. This phase takes <8> seconds.

2. 2nd Observation phase: Little longer purple blinks appear on several ambience lights around the players. If the players recognise these and any of them decides to start fighting back the indians, the current round stops and the players start the fight. This phase takes <8> seconds.

3. 1st Fight phase: The indians arrived and ready to attack. The desk lamp changes its light to purple which indicates a change of the game state. The ongoing round stops and players have to start fighting the indians. This phase takes <5> seconds.

4. 2nd Fight phase: The indians start their attacks. This is indicated by more saturated purple blinks on the ambience lamps around the players. This phase takes <8> seconds.

5. 3rd Fight phase: The indians start shooting with their blue arrows. This is indicated by blue blinks on the ambience lamps around the players. This phase takes <8> seconds.

After the fight, despite of the fact if the indians or the players won, the normal rounds continue by restarting the player’s round whose round was stopped at the start of the battle.

4. Extensional rules of the extended game without light

Night

After every <2> rounds the sun sets and **two** players have a chance to rob the bank. They can earn <2> life points in case successfully finding the combination of the safe in the dark, before the guard (3rd player) catches them.

1. The two bank robbers first positions the bags of dice close to them, then put on the eye blinds.
2. The guard starts the timer (20 sec) and tells the players when they can start.
3. After that, the two bank robbers can open the bags, and start to put down all their dice on the table with ***different*** symbols facing up on all of them. They can do this buy using their tapping skills to distinguish between the different symbols.
4. When the time is over, the guard lets the robbers know about it by saying: “Good morning!” Or in any other way.

a. The robbers who still had any dice in their hands at this moment get shot by the guard. So they lose one life point. The guard gets as many life points as many robbers he caught.

b. The players whose dice were already on the table with the correct combination gain <2> life points.

c. The players whose dice were already on the table, but with not the correct combination do not get or lose any life points.

The first two robbers are the Deputy and the Renegade. In the next round the Outlaw replaces the Deputy and so forth.

Sand Storm

In the beginning of every player turn, the players roll the big dice. In case, the result is sand storm <1,2>, the two other players turn their role cards up-side-down and mix them. As a result, the aiming player cannot be sure who he is shooting.

Indian attack

At the end of every player turn, when the number of arrows in the middle is <4> or less, the current player rolls the big dice. In case, the result is indian attack <1,2>, the players has to start the indian timer <30 sec> and fight back the indians.

Indians can be fought by having 5 dynamites rolled. One player can only roll one dice at a time. In case the players cannot roll 5 dynamites in time, they lose against the indians and each of them loses as many life points as many arrows they have in front of them at the moment. Otherwise everyone can put back <2> arrows.